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J. A. BERLY'S

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For 1893,

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HEAT ENERGY OR ILLUMINATION?

IT has frequently been pointed out in the ELECTRICAL REVIEW that, in the near future, the gas companies must lay themselves out to the catering of fuel, not light, if they are to secure the handsome dividends which they have been able to earn in the past. From all those points of view, which are likely to be considered by a sensible and far-seeing consumer, the electric light shows to much better advantage than do even the best forms of gas-light. The gas managers should study how to produce the highest calorific power, and not waste their skilled energies in vainly endeavouring to secure a greater illuminating power. There are great difficulties in the way, we admit, and to meet them many proposals have been made, one group of suggestions involving the supply of two distinct gases, an illuminating and a fuel gas, and therefore requiring two sets of mains; but Prof. J. Emerson Reynolds, M.D., D.Sc., F.R.S., has recently issued the warning, that "the progress of electric lighting is so rapid that gas companies would not be justified in outlay of capital on a second set of mains." And we might also remind them of the fate of the man who tried to sit upon two stools at once.

If there is one subject upon which Prof. Reynolds is entitled to be heard, more, perhaps, than on any other, it is the commercial importance of coal, peat, petroleum, and the use to which these substances can be applied in illumination. Indeed, in his presidential address to the Society of Chemical Industry the other day, he chose this as his chief topic, and speaking from this position of eminence, he was able to enforce some truths concerning gas, which must prove very unpleasant reading to the shareholders of gas companies if they should happen to read of them.

The Professor is evidently desirous that gas should be regarded more as a heating agent, and he said that as an illuminant it "is being so certainly displaced by the electric light, that the objections hitherto urged against the supply of gas of high calorific value, but low illuminating power, have almost ceased to have any practical force." Thus we see an independent authority viewing the position in the same light as we do, and, knowing full well the capabilities of coal gas, urging that it should be regarded in the future rather as a fuel than as an illuminant. The Professor said: "The rapid extension of electric lighting in our large towns brings us within measurable distance of some such sweeping change in the character of the gas used, in its applications, and in its mode of employment, while the existing mains would serve for its conveyance, and comparatively trifling alterations in our domestic appliances would only be necessary." The illumination of private dwellings and public places he leaves to US!

We have always argued that a general illumination by electricity, and heating by gas, would practically do away

with the worst features of the fog difficulty, which is one of the greatest curses of our large towns; and we are gratified to find that Prof. Reynolds is at one with us. He said: "It is in this direction that the best prospect of solving a considerable part of the smoke-fog difficulty seems to lie, and it is in the same direction that we are to look for true economy in the use of coal. The completion of the system of electric lighting in towns is therefore to be desired by the community, not only on account of its great and obvious advantages for illumination, but because it will make possible the provision and distribution of a cheap gas for heating purposes; and the shareholders in gas companies of such fortunate towns should specially rejoice, as herein lies a good prospect not merely of maintaining, but of considerably increasing their dividends. Gas companies would not only become purveyors of heat energy for domestic use, but for many manufacturing purposes as well, not excepting the production of electric light."

Whilst fully endorsing Prof. Reynold's exhortations to the gas shareholders to *rejoice* at the glorious future before them, we can assure him that they won't: their policy is too short-sighted to allow them to look ahead with satisfaction, much less jubilation, to such a radical change. We do all we can to "cheer them up a bit," but they are getting into "doleful dumps." They won't see that it is their duty to posterity and to their own immediate interests to join in using more economical methods of employing coal; for the conversion of this substance into gaseous fuel as far as possible will make the coal-fields last longer besides offering the greatest number of present advantages.

Were it not for their despair, we were almost tempted to impress them that it is only *for the present* that we leave the supply of heat-energy to them, so that they had better make the best of what yet remains to them and then write *Hic Jacet*.

INCALCULABLE ACCIDENTS.

ALARMISTS are ever on the *qui vive* to point out that as the accessories to civilisation are multiplied, the dangers to health and life are proportionately increased. There is some truth in this, but most people are content to accept these conditions, because of the "set off" which they involve: for no one will contend that we do not enjoy greater comforts, increased business facilities, and altogether a fuller life now than we did even 10 years ago. Rapidly growing power is at present accompanied by rapidly growing risk—a condition to be expected during early stages of advancement. But relative safety will doubtless be attained through the skill of armies of specialists, who will be divided and subdivided into a greater number of groups as the new combinations multiply. Herbert Spencer's doctrine of the increase of heterogeneity during certain stages of evolution is thus re-affirmed in this age of mechanism; and there is every reason to expect that the development of intelligence will steadily eliminate the dangers arising from haste and insufficiency in construction.

Such considerations have a special import in connection with the dangers which accompany the applications of electricity. We do not close our eyes to the fact that there are risks attending the employment of the latest form of energy which we have enlisted in our service; but we do assert that, compared with the yearly death-roll due to gas explosions, railway disasters, and even street accidents, that from electricity, in all its applications, stands out almost free; and alarmists are at liberty to make as much legitimate capital out of this admission as they please: we only ask for fair treatment.

The fact is that in most of the operations connected with the manipulation of high power there are dangers which lead to accidents of the kind termed recently by Mr. Wm. A. Eddy, "incalculable," and such accidents are more common to the working of railways, mines, and to engineering generally, than to electrical engineering. The growing complications of modern life are such that the highest form of natural shrewdness is almost inoperative under circumstances which only rarely exist.

Electrical engineering is the youngest branch of applied science, and yet we dare assert that it has the cleanest death-roll. We go still further, and express our opinion that year by year the experienced intelligence which is beginning to characterise even the rank and file will reduce the list of accidents to a minimum. We are not afraid of the future; it is full of promise for our profession, and we can guarantee to safeguard the health and lives of the public. Some dreadful accidents have occurred, we know, but they have been isolated, and need never be repeated. Electricity does not kill people wholesale. If we are to be judged, let the verdict be given fairly. Let the yearly average of fatal accidents connected with illumination by electricity be taken over a period of the last ten years, and compared with the average death rate due to oil lamp and coal gas explosions, &c., and let a similar comparison be made of the death rates due to street locomotion, railway locomotion, or travelling by sea, with the death rate due to the transmission of power by electricity. We do not tremble for the verdict.

A Theosophist on Magnetism.

WHEN ladies enter the arena of literature or science, it may be presumed that they are willing to forego many of the privileges of their sex. Whatever the general feeling may be, we may be quite certain that Mrs. Annie Besant expects and desires no consideration other than would be accorded to any male "human" who chose to challenge criticism. Concerning her efforts towards the amelioration of the race, we do not feel called upon to express any opinion, beyond that—however directed—we believe them to be inspired by serious conviction. When, however, Mrs. Besant undertakes to deal with matters which relate, though ever so slightly, to our special province, we feel justified in indicating the errors she commits. The *English Mechanic and World of Science* for August 26th, contains the first of a series of articles by Mrs. Besant, entitled "Mesmerism and Hypnotism," in which the writer selects for study "that part of the borderland of physics and physiology" which, she says, has been variously called "Animal magnetism, mesmerism, hypnotism, &c." She starts with a review of what has been known of this subject since the days of the pre-Christian Greeks, and at once slips into the unpardonable error of confusing the so-called "magnetism" alleged to exist in the human body with the magnetism that exists in, or may be imparted to

some forms of inorganic matter. Surely Mrs. Besant does not intentionally patter in the cackle of the charlatan? If not, why does she endorse the archaic theories of Paracelsus, Cardan, Van Helmont, and Sebastian Wirdig? The quotations she gives from some of these worthies might well adorn the circulars of the nineteenth century quacks. Later on in her paper, Mrs. Besant appears to mean by human magnetism the "something" with which mesmerists conjure. Mesmer's theory of physical forces is reduced to the following statement, which, whatever other charms it may have, is certainly not remarkable for its lucidity. "That a universally diffused continuous fluid, incomparably subtle, and able to receive, propagate, and communicate all motor disturbances, is the means of an influence existing between the heavenly bodies, the earth, and living bodies; that the properties of matter and of organic substance depend on this influence, or mutual interaction, and that the animal body is directly affected by the permeation of the nervous substance with this fluid; that properties are shown, particularly in the human body, analogous to those of the magnet; that experiments prove the diffusion of a form of matter, magnetic in its nature, subtle enough to permeate all bodies without much loss of energy, and capable of reflection by mirrors, of communication, propagation, and increase by sound; that this principle helps to show the nature of fire, light, attraction, flux and reflux, magnetism, and electricity; that it will cure nervous diseases directly, and other diseases indirectly." As they read this modern physicists will stand aghast, although Mrs. Besant *does* state that it remains "as a monument to his (Mesmer's) knowledge and insight." The lady may be carried away, as ladies of a certain temperament are rather apt to be, by the mellifluous mouthings of her great high priest, and her unreasoning admiration may be classed with other frailties of the sex. We can only wonder that such things be. She places herself still further beyond our comprehension when she quotes Sebastian Wirdig from the *Isis Revelata*, p. 15, as follows: "All the world consists of and exists in magnetism; all sublunary changes are wrought by magnetism; life is preserved by magnetism; in fact, all things are done by magnetism." And she caps this by saying, "As we shall see later, this all-permeating magnetic substance is a form of what our scientists call ether, and Wirdig was right enough!" What is to be done with this daring writer who so jauntily dismisses matters of the most profound moment? We might suggest an elementary course at South Kensington, or——. But we must pause. Mrs. Besant is, after all, a lady, and will probably console herself, like Paracelsus, with the thought that she is "too great and too far ahead of her time" to escape what she will be pleased to term "the abuse of mediocrity."

Electrical Phenomena at Waterfalls.

IT has long been known that the air in the immediate neighbourhood of waterfalls is charged with negative electricity, but comparatively little has been done in the way of experimental investigation of this phenomenon, although Thomson's water-dropping collector resembling in principle a method proposed years ago by Volta is familiar to us. There have been several researches in this country the results of which bear upon the subject; for example, in 1890, there was a paper by Messrs. Maclean and M. Goto in the *Philosophical Magazine*. Lord Rayleigh's paper in the *Proceedings of the Royal Society* ten years ago, relates to it, and there was one a few years later in the *Philosophical Magazine*, by Mr. Boys. In Germany the work of Elster and Geitel has been conspicuous; in France that of Bichat and Blondlot. *Wiedemann's Annalen der Physik und Chemie*, 1892, No. 8 contains an important contribution to this curious subject by P. Lenard in which he reviews the present state of our knowledge concerning it, and gives a detailed account extending over upwards of 50 pages of his own experimental researches. He has made numerous observations the results of which are classified in 17 tables, and which show that he has opened up a field of research that is likely to be very fruitful. Many of the experiments were made *in situ*, others were carried out on a laboratory scale in the Physical Department of the University of Bonn with liquids other than water, *e.g.*, turpentine, alcohol, ammonia, quicksilver, &c. The instruments and the methods of observation employed are fully described in the *Annalen*.

Transformers.

MONS. F. GERALDY publishes in *La Lumière Electrique*, a very interesting article on the transformers of the "Société d'Eclairage Electrique." It appears that these transformers have as high an efficiency as 86 per cent. at one-eighth full load, and 97 per cent. at full load: they are also said to require under 2 per cent. of the full power to excite them. Special precautions are taken with regard to ventilation, especially between the core and the coils; this is said to keep the latter much cooler than is usual, and hence assists in preventing ohmic drop. M. Geraldy estimates the total drop at 1 per cent., but he apparently neglects the inductive drop. This is again occupying Mr. Swinburne in *Industries*; these two articles are very interesting, and give a very simple method of investigating the question. As one would expect, the open-circuit type gives a greater inductive drop, owing to its large magnetising current: fortunately, this is easily allowed for. M. Geraldy appears to think that open circuit transformers are quite a mistake. He appears to have used a method of measuring the efficiency very like the one recently described by Dr. W. E. Sumpner, as he puts one transformer to work into the other, and measures the total output after the double transformation.

A Faraday Experiment Amplified.

STUDENTS of Faraday's researches may remember that he succeeded in demonstrating the separation of precipitates at the boundary of electrolytes. He took a U-tube, and in each limb put a small quantity of water, above which he placed a layer of magnesium sulphate in saturated solution in such a way that the liquids did not mingle; he then passed a current of electricity through the tube, and noted that a precipitate of magnesium hydroxide was formed below the negative electrode, just at the surface of contact of the two liquids, water and magnesium sulphate solution. Others who have followed up this line of research have found that some other metallic sulphates may replace the magnesium sulphate without affecting the character of the phenomena which appear at the negative electrode. More recently G. Kümmel has been giving some attention to this subject, and has made the curious discovery that instead of using water for dissolving the sulphates, gelatine, which solidifies on cooling, may be employed. The advantage of the gelatine is obvious, for the line of demarcation between the solutions may be, by means of it, easily and clearly defined, whereas it is very difficult to prevent intermingling when water solutions are experimented with. Kümmel has examined the behaviour of various sulphates in gelatine solution but finds that only those of magnesium, zinc, aluminium and cadmium afford a precipitate under the circumstances described. The separation of the hydroxide always occurs first at the negative electrode, and after the current has been passing a little while it then becomes manifest at the boundary of the electrolytes. As a reason for this curious phenomenon, Kümmel suggests that the electric current carries the solid particles from the negative electrode through the feebly conducting water until they reach the boundary of the electrolytes, at which *locus* they accumulate.

DEVELOPMENTS OF ELECTRICAL DISTRIBUTION.*

II.

WHERE electric motors have been run from the same supply mains which supply lighting circuits, difficulties have arisen in some instances, and as a remedy for the trouble it is proposed to run motors on separate circuits, and even to provide separate machinery for the motor circuits.

Now, such difficulties cannot arise in any distribution plant laid down with a view to run motors all day, and lighting current at any time during the 24 hours. The difficulties have arisen when all day motors supply has been added to a distribution system designed only for lighting in the first instance; many supply systems have been put down, and are being put down, on the most shortsighted policy, and upon most incompetent advice, and one of the consequences is that difficulty with motors referred to in these Cantor lectures.

The difficulties are referred to thus: "If the motors are not under the same conditions as the lights and are doing heavy work, or are put on suddenly to heavy work, a strain is put upon the electrical supply in the immediate neighbourhood, and the lamps in the vicinity become dim."

The lamps in the immediate vicinity on any system which exhibited the above symptoms, would also become equally dim if a large number of additional lamps were switched on; the fall of pressure is not at all due to the motor, simply because it is a motor; it is entirely due to the mains or feeders, or both of them, being too small for the work put upon them, and it would seem more sensible to put down additional feeders and mains than to run separate circuits for motors.

One chief reason for putting motors on the lighting circuit was that the load factor would be improved.

This is said not to be the case, the reason given being that the lighting and power overlap at the busy time.

It is not self-evident, and has not yet been demonstrated at all, that the addition of motors on any system in which the supply is designed for both light and power, "does not improve the load factor." One thing is certain, it would very much improve the load factor in any system employing storage; and whether it improves the load factor or not on any direct system, alternating or continuous, we know from experience that an all-day load pays dividends.

The overlapping of the loads means nothing more than that the machinery must be large enough to cope with the maximum output for a short time daily. It would save nothing to label some of the machinery, "for motor supply only;" neither would it save anything to label some of the feeders and mains, "for motors only."

The arguments applied by Prof. Forbes in favour of sub-station supply by alternating currents are very strong, and well worth the attention of some of our so-called consulting engineers.

The difficulty in obtaining continuous current from alternating current is still as great as ever. Only by means of a motor generator, consisting of an alternating motor coupled to a continuous current generator can a continuous current be obtained from a simple alternating current.

The commutator method referred to by Prof. Forbes is not practicable, a commutator cannot render an alternating current continuous; it can only make it a pulsating current rising from zero to a maximum, and falling from a maximum to zero regularly. Such a current cannot efficiently charge batteries, as during the period in the pulsations when the E.M.F. or pressure falls below the counter pressure of the batteries, the batteries are being discharged into the generator, so that something like an alternating current is set up in the conductors leading to the batteries. This effect occurs whatever the frequency of the alternating current from which the pulsatory current is derived, so that the proposal to employ exceedingly low frequency does not meet this difficulty.

Only multiphase currents can be converted into continuous currents steady enough to charge batteries by commutators.

If we introduce sub-stations fed by multiphase feeders, we could convert and deliver continuous currents into the distributing mains, so that ordinary motors can be used; there, again, we find no need for exceedingly low frequency; there would be no alternating motors wanted, all the current distributed would be continuous current. On the other hand, low frequency currents would be intolerable for lighting purposes, whereas by preserving the frequency above 60 per second, the alternating current can be used for lighting if desired, at any point of the system.

The reasons given for the adoption of very low frequency will not bear close scrutiny. Low frequency, as we have shown, does not render a simple alternating current any better for conversion into a continuous current than high frequency, when a commutator is employed for that purpose. Neither does low frequency solve the motor question.

It is admitted that high pressure must be employed for transmission of the electrical energy to sub-stations, and it is also admitted that low pressure must be used for distribution. That being so, it becomes very necessary, in the words of the lecturer, to "review the whole system of distribution, and consider whether we are working in the right direction."

It must be evident that the transmission current must be one not only easily transformed down in pressure, but also one easily converted, without heavy machinery, into a continuous current. Multiphase currents alone can fulfil these two conditions.

The art of electrical distribution is altogether too young to enable us to settle down to stereotyped practice. Invention, experience, skill and enterprise have much to do yet in perfecting the many details of a successful system; successful, not only practically, and thoroughly reliable, but also financially.

Electricity must be offered to the public at a price which makes its use as motive power, as well as lighting, economical.

* Prof. Forbes's Cantor Lectures.

ELECTRICAL DISTRIBUTION BY MULTIPHASE CURRENTS.

BY RANKIN KENNEDY.

A PLAN for electrical distribution at low pressure by continuous currents, derived from high pressure multiphase currents, was recently proposed and brought before the Society of Engineers and Shipbuilders, Glasgow, by the author.

In this scheme, the electrical energy was to be generated at a station conveniently situated, where coal and water could be easily conveyed, and outside of the town or city, on cheap land. From this station the electrical energy is to be transmitted in currents at high pressure, and alternating in two or three different phases. These currents are to be received into sub-stations, conveniently situated in the districts to be supplied with the low pressure continuous currents.

In a sketch plan of the city of Glasgow, sub-stations were taken as shown in fig. 1. At *c* is the central generating

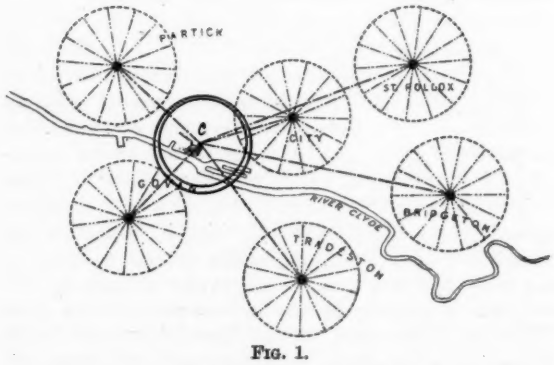


FIG. 1.

station on the river Clyde, where coals can be delivered direct from ships or barges at a cost of about 6s. to 7s. per ton. Ashes can be shipped off easily without cost for cartage, &c. Water, for condensing, can be obtained for nothing, except cost of pumping it up. In fig. 1, seven districts are shown in circles, as covering all Glasgow. The double circle round

the generating station would represent the district within a quarter mile radius of the central station. This district would take its supply at low pressure direct from the generating station; the other six districts would be supplied by high pressure feeders carrying multiphase currents.

There are two strong arguments in favour of multiphase currents employed to transmit electrical energy over long distances at high pressures:—

1. They are easily generated by simple dynamos having no commutators nor brushes, so that there are no difficulties with high pressures up to 10,000 volts or so. The efficiency of these generators can be made to give a return of over 90 per cent.

2. Multiphase currents can be easily and economically reduced to any safe pressure and converted into continuous currents.

In this system there is, first, a central generating station, which may be a considerable distance from the districts to be fed from it. This station contains all the generating plant for a whole city or town; secondly, a system of high pressure feeders running from the generating station to any number of sub-stations; thirdly, there is to be low pressure continuous current derived from the high pressure supply and distributed throughout the districts surrounding the sub-stations in a low pressure network.

The concentration of the generating plant, capable of supplying a whole city or town, offers many advantages, not the least of which would be the levelling up of the load diagram, in a station supplying various districts and delivering electrical energy as a continuous low pressure current to consumers, suitable for all purposes to which electricity can be supplied. The all-day load can evidently be kept up to a pretty constant level, the current being used for power and other purposes during the day. At any sub-station, where a sudden rise takes place daily in the load, a storage battery would be laid down to level up the load at that point.

It has been argued that it is not advisable to run power and light off the same plant, the reason given being that the motor load and the lighting load overlap at certain times so as to throw an extra heavy load on the generators at these times; the remedy proposed by those people who use the argument is, to run motors on separate circuits from the lighting circuits; both the argument and the method proposed are utterly absurd.

Even, granted, there are no storage batteries to level up the load, the overlapping of the power and the lighting load curves can in no way whatever be a disadvantage. The sudden rise of the lighting load is an evil which is present whether motors are on the circuit or not; placing the motors on another circuit can in no way level the load line.

There is one way only by which a steady all-day load can be approached, and that is by using storage.

Although this new system is an alternating transmission system, the distribution is a continuous current low pressure one, storage can be employed to any extent, and the load on the generators kept almost constant at the generating station.

It will be evident that the sub-station on this scheme becomes of great interest, as upon it seems to turn the whole practicability of the system. The problem at the sub-station is to transform the high pressure feeding current into a low pressure distributing current. If the feeding current were a high pressure continuous current, then it could be transformed by a motor generator or by a huge series of batteries. Neither of these processes are either practicable or economical at high pressures; they were therefore abandoned.

If the feeding current were an alternating current, then there would be nothing easier than to transform it to low pressure; but, then, to convert it into a continuous current, is a very difficult matter; it could be done by a motor generator, but not economically, and that, the only method, is impracticable, hence the alternating current had to be abandoned.

If the feeding current were a multiphase current, then transforming from high to low pressure is a very simple and economical process perfectly practicable, and the conversion of this multiphase current into a continuous current is also economical and practicable, hence multiphase currents were adopted to feed the sub-stations in this scheme.

Fig. 2 is a diagram of a sub-station for a two-phase current in feeders, *a*, *b*. On arrival at the sub-station the first step is to transform down the high pressure currents; this is done in two ordinary stationary transformers, C, D.

After being brought down to the desired low pressure, the next step is to convert the two-phase currents into a low pressure continuous current. That can be done in three different methods; first, by a motor generator; secondly, by a rotary current motor fitted with a commutator; thirdly, by two or more commutators driven by synchronising alternating current motors. The third method is the one adopted by the author. It is quite a new method, and has been misunderstood by some critics.

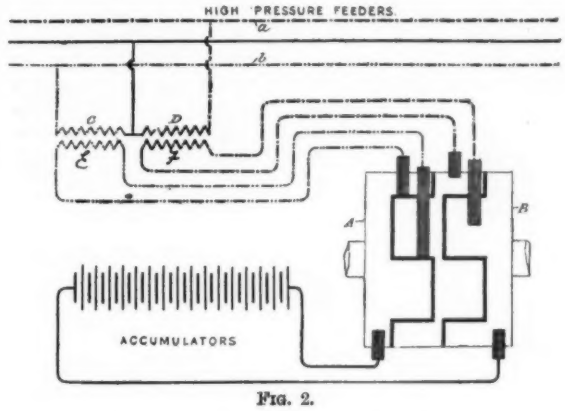


FIG. 2.

In fig. 2 the two commutators are built together on one shaft, the secondary, E, goes to one commutator, A, and secondary F, goes to another commutator, B. The two commutators are coupled in series, putting the two currents in series. The continuous current is shown in fig. 2 as being taken from the commutators to an accumulator.

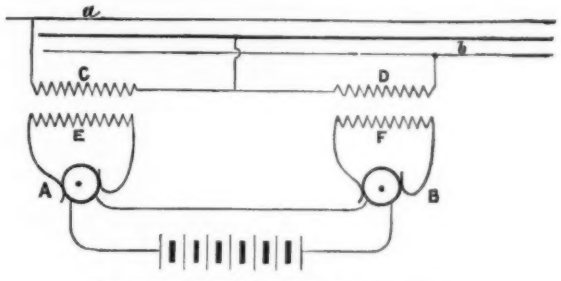


FIG. 3.—KENNEDY'S TWO-PHASE CONVERTER.

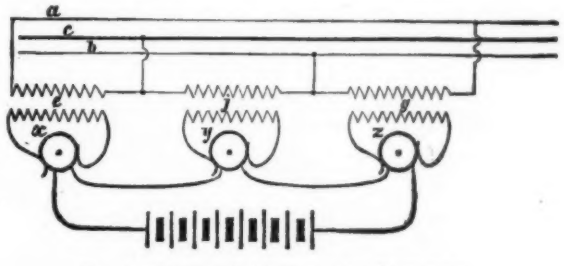


FIG. 4.—KENNEDY'S THREE-PHASE CONVERTER.

Figs. 3 and 4 are diagrams of this method of converting multiphase currents into continuous currents. Fig. 3 refers to a two-phase converter, and fig. 4 to a three-phase. The secondaries are shown in series, with commutators to rectify each current. The commutators may be all on one spindle of a synchronising motor, but the author prefers to place each commutator on its own synchronising motor, and to drive this motor by the current which the commutator is rectifying.

In this method of converting, the rectifying of the currents is all that is performed by the motors and commutators, there is, therefore, no appreciable power wasted, and the motors are small affairs, however large the amount of current converted. The conversion is perfectly accomplished, as the motors must keep perfect step with the alternations of the current, there being no load to retard the armature, and no self-induction to vary the phase of the one current more than the other.

Such a method of conversion does not require any large space, and requires no foundations for heavy machinery; one attendant only would be required, whose duties would be to look after the commutators, brushes, and lubrication, and attend to the accumulators.

The foregoing is a sketch of the system proposed by the author as a solution of the problem of electrical distribution in towns and cities. Designed to meet every requirement, and one in which every facility for future extensions is given, it may be worked on a small scale as well as on the large scale sketched herein.

It may be observed that it opens up a vast field for the employment of storage batteries under the very best and most favourable circumstances for high efficiency and usefulness. Alternating generators are employed, while everybody's continuous current motors may be used by the consumers anywhere on the system.

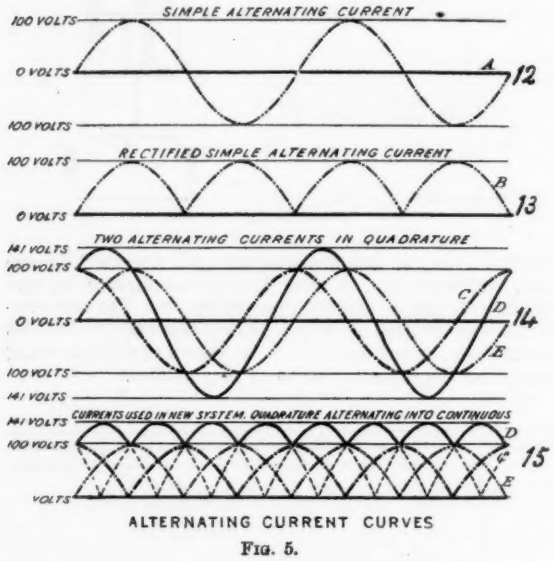


FIG. 5.

Fig. 5 shows the curves of various currents. This method of conversion of multiphase currents into continuous currents depends on rectifying the alternating currents separately, and then connecting them in series; thus in a two-phase conversion the one current is at its maximum value at the moment the other is at its minimum value, giving a resultant as shown in curves 14. When these are rectified and put in series by the two commutators, curves 15 are obtained, showing that the pressure never falls below 100 volts when the maximum resultant pressure is 141 volts. Of course, with three-phase currents, the difference between the maximum resultant pressure and the steady minimum pressure of the combined rectified currents is much less.

THE THERAPEUTIC EFFECTS OF THE ALTERNATING CURRENT.

THE following is a paper recently read by Dr. Larat before the Société Internationale des Electriciens :—

With the exception of the interesting communications from our eminent colleague M. D'Arsonval, who has submitted to you principally physiological questions, I think no medical question has been brought before the Society since the death of my lamented friend Dr. Boudet de Pâris, whose abilities as an orator and *savant* you have all been able to appreciate. However, while you have been occupied with the various problems of electricity as applied to industry, we doctors have not been idle, but have been occupying ourselves with the less brilliant, but not less useful, object of relieving our fellow creatures by means of the new forces introduced by electricity into the healing art. I bring you to-day, on the part of Dr. Gautier, my collaborator and friend, and myself, the result of our researches with regard to the therapeutic application of alternating currents, researches which now seem to us sufficiently firmly established to justify at least the hope that we have in our hands from this time henceforth a mode of treatment which is of considerable power, and very interesting, for alleviating chronic nutritive disorders, *i.e.*, diatheses, and the morbid conditions resulting from them.

The idea that electrical energy is capable of acting powerfully on the inward working of our system is not new; we find traces of it in works written by charlatans at the end of the last century, and since then the greater number of writers on the subject of medical electrology have alluded to this possible, probable, but not demonstrated influence.

This demonstration we owe to our learned master and friend M. D'Arsonval. He came before you some weeks ago to submit to you the result of his physiological researches, which enable him to vary, almost at will, the nutritive condition of the animal or individual in a normal state of health. What we had to do, then, was to apply these data to the sick man, and to ascertain whether the results observed physiologically with healthy individuals, whose nutrition is normal, would be reproduced in sick persons, *i.e.*, in those suffering from nutritive disorders.

The answer is affirmative: Yes, it is possible, and, I may add, very easy to improve the nutritive powers of a chronic invalid; defective nutrition being in many cases the result of disease, although very often it is the cause of it. To give you an idea of the importance of this demonstration, I will briefly run over the results obtained by M. D'Arsonval in his experiments.

M. D'Arsonval based his estimation of the nutritive modifications undergone by the animal experimented upon on the measurement of the *respiratory capacity* of the blood. This is really the surest of all methods. You know that the red globule, which is the really active part of the blood, is capable, normally, of absorbing a certain quantity of oxygen. This absorption, which takes place in the lungs, varies within certain physiological limits. It is most active when the animal is doing most work, and falls to a minimum when it is at rest.

When the cells, which are the ultimate constituents of all the living tissues are endowed with greater activity, they demand from the globule more oxygen, and the examination of a determined quantity of blood under the mercury pump shows the increase of what has been called *the respiratory capacity of the blood.*

There is, therefore, correlation between the respiratory capacity and the nutritive activity, the first of the terms serving to determine the second.

M. D'Arsonval has examined in succession the various applications of electricity to medical purposes, to see what influence they are capable of exercising on these phenomena.

He showed that the continuous current without fluctuations produced no action; that the static current had an action that was appreciable, but feeble, causing the respiratory capacity to vary from 12 to 15 per cent.; while the alternating current produced the augmentation of this same respiratory capacity in the proportion of 50 per cent. As to the faradic current, it certainly produces increased organic combustion; but indirectly, by contracting the muscle that is working, and, consequently, consuming. The interesting and important part about the results obtained with the alternating currents is that the increase in the respiratory capacity manifests itself without any muscular contraction, or even any sensation. There is, therefore, a direct effect on the nervous nutritive function which imparts to the cells their activity.

The alternating current having shown itself so much more efficacious than the other forms of electricity, it was naturally the one chosen for acting upon the sick. M. D'Arsonval, in his experiments, used a current that was strictly sinusoidal. He thus endeavoured to dissociate the two effects of the current, the direct nutritive action, and the action on the contractile muscular fibre.

The strictly sinusoidal form of the current enabled him to avoid this last action—the contraction, which, as you know, manifests itself at the moment of the falls of potential. Practically, from the point of view of its application to the sick, the object was slightly different, since, on the one hand, the alternating current increases the nutritive action on the nervous centres by a mechanism which, although as yet obscure, is undeniable, and since, on the other, the faradic current, by the muscular contractions which it provokes, leads indirectly to a similar result, it would be beneficial, we thought, to associate these effects, which would thus

reinforce one another. The problem being set, it remained for us to solve it from an instrumental point of view. The current supplied by our medical coils was far from giving us the solution required. The current produced by battery elements in connection with an inductor and an interrupter, and working an induced coil is certainly alternating, but the breaking current, weakened by the extra current, is considerably weaker than the starting current; moreover, the duration of the passage of the current is very short, and the time lost is at least two-thirds of the time utilised. As to the coil known as Constantine Paul's, and used by that physician for the faradic baths, it is less suited to our purpose than any other; it gives the extra current from a thick wire coil, and, consequently, a current of the same nature and of excessively short duration. In short, the current supplied by these coils only act by the muscular contraction which they provoke.

We were, therefore, led to conclude that the best and most practical plan was to borrow our current from the alternating circuit supplied for lighting purposes by the Halles Electrical Works, and generated by Ferranti-Patin dynamos. This current comes to us under a potential of 110 volts, and by means of a little transformer, and an intercalary resistance with a soft iron core, we are able to use from 1 to 100 volts; as to current, our starting point is 1 milliampère. The number of alternations is 10,000 a minute. The graphic representation of this current indicates that its sinusoid is more acute than that furnished by D'Arsonval's apparatus, but it is regular nevertheless.

As regards the mode of application, we thought that as we required to produce general effects, it was expedient to enlarge, as far as possible, the active surface of the electrodes; this object is attained by placing the patient in a porcelain bath, so that he is in derivation, and only takes a fraction of the current passing through the water in the bath.

Such an installation is extremely practical. The regulation of the quantity of current supplied is very simple, and it can be increased quite progressively. I will now briefly relate the results attained.

You know that there is a large class of maladies that have been grouped by Prof. Bouchard under the title of maladies caused by failing nutrition (*maladies par relentissement de la nutrition*). Amongst these maladies, which are all, it seems, brought about by a sort of failure of the nutritive powers, taking different forms according to individuals, races, temperaments, &c., may be included gout, chronic rheumatism, obesity, diabetes, &c.

It is to patients of this class, *those suffering from defective nutrition*, that our endeavours have been directed. To obtain our starting point, and ascertain the state of the oxidations which, as we have seen, are amongst the primordial phenomena constituting cellular life, we could not, like M. D'Arsonval, measure the respiratory capacity of our patients' blood. We contented ourselves with analysing the urinary discharges, which show unfailingly the processes of organic combustion going on in the living tissues. But of course this method is not wholly reliable. The diet of the patient considerably affects the quantity of nitrogenous products discharged in 24 hours: a meat diet increases the quantity of urea, as we know, and a vegetarian diet considerably diminishes it. This is why, when experimenting upon animals, we subject them to a strict regimen, consisting of rations which are invariably the same, both in quantity and quality. We could not ask our patients to submit to a regimen of this kind; but I think our figures may be considered correct, on account of the number of analyses made with regard to one patient, which enabled us to establish mean values.

In a general way, we may say that with those patients in whom the quantity of urea is too low, we note that this quantity rapidly increases, reaches the normal value, and often exceeds it.

With gouty subjects suffering from an excess of uric acid, this acid acts in a contrary manner, diminishing in quantity. In two out of three cases of diabetes, the sugar diminished; in another case it remained stationary. The quantity of urea in patients of this class being very high in consequence of over-alimentation, no modification was observed in the excretion of this product. Moreover, it is only by continuing and multiplying these chemical researches that it will be possible to draw certain deductions from them. The physical functions do not proceed as simply in a sick person as in an animal, or a healthy person, experimented upon in a laboratory. But what has struck us is, that the great majority of our patients have been wonderfully improved.

We treated several patients suffering from excessive corpulence, who lost from 5 to 10 kilogrammes in a few weeks; and some suffering from chronic gout, who had been confined to their rooms for months, and who now go about in comfort.

Several dyspeptics, with dilatation of the stomach, have also undergone a decided improvement in their general health and in their digestions. The details of our cases will shortly be laid before medical societies; I need not dwell further on them here, but if I had to state my general impression as to the results of the treatment by baths traversed by alternating currents, I should say that the nervous system which is depressed or the functions of which are turned aside from their regular course, seems to be deeply and favourably influenced. Our attention was also directed to chronic diseases of the skin, especially eczema. Three cases of eczema were so quickly improved that we were encouraged to continue our efforts. We take this opportunity of thanking Profs. Besnier and Hallopeau, who have been kind enough to entrust some of their patients to our care, and who follow our researches with interest.

The domain of electro-therapeutics, which has been up to the present almost confined to local applications, or, if used for general treatment, has been restricted almost exclusively to nervous affections, is being greatly extended, as you see, since it now deals with the nutritive disorders that constitute diatheses, which are the sources of a number of chronic maladies. As to ourselves, we do not claim to have discovered this action of electricity on the system generally which has been glanced at by several of our predecessors, which was, so to speak, in the air, but which M. D'Arsonval has clearly and accurately defined. We simply claim priority as far as concerns the systematic application of electricity to diatheses, especially in the form of sinusoidal currents.

Vibrating instruments.—Allow me now, gentlemen, to submit to you some researches of another character, which cannot be considered as derived from electricity, since that agent is only employed in them as the motive power, but, nevertheless, they may be of interest to you. Our subject is the mechanical vibrations employed to act upon the morbid conditions of the sensitive nervous system.

About 10 years' ago, Dr. Vigouroux and my friend Dr. Boudet de Pâris, each began some researches with this object, but subsequently abandoned them. They had constructed a series of diapasons, moved by an electro-magnet and transmitting their vibrations to certain localised parts of the body, either by means of a button applied to the flesh, to which the diapason transmitted its vibration, or through the medium of the air vibrating in a resonance box.

This question was afterwards taken up in England by Dr. Mortimer-Granville. His *vibrator*, which was moved by clockwork, gave vibrations that were more ample than than those of the diapason, and, from a therapeutic point of view, the results he obtained seemed so interesting to our eminent physician, Prof. Charcot, that he instructed my friend, Dr. Gilles de la Tourette, and ourselves to study mechanical vibrations. The first thing to be done was to invent practical instruments.

What discouraged the experimentalists whom I have just mentioned was the inconstancy and defectiveness of their instruments. The diapason gives very rapid vibrations, the number of which is, to all intents, constant. But these vibrations are very feeble, unless an enormous diapason is used. Mortimer-Granville's vibrator only partially effects the purpose required. It is a little hammer moved rapidly by clockwork, which strikes light, but very rapid blows on any desired point. Now the opinion of Boudet de Pâris, which seems to be the true one with regard to the therapeutic effects of mechanical vibrations is, that the action which is quite appreciable when applied to a nerve, becomes much more powerful when the cerebro-spinal centres are made to vibrate; thus Boudet applied the button of his diapason to the forehead.

Adopting this theory, which is the outcome of a number of experiments and facts which would take too long to give in detail, we proposed to construct an apparatus capable of imparting to the cerebro-spinal mass a rapid and sufficiently powerful oscillatory movement.

After many trials, and with the skilful collaboration of our

colleague, M. Gaiffe, we at length decided upon the model before you.

It is a casque, of a form vaguely resembling that adopted by hatters, formed of a series of plates, taking the form of the head, and capable of being removed at will. At the top of this casque is the apparatus intended to make it vibrate, which consists of a little electric motor, whose centre of gravity, by means of a copper weight arranged in the manner of an eccentric, is thrown outside the axis. At each half-turn the apparatus, by centrifugal force, tends to rise when the weight is at the top, and to fall again when it is at the bottom. It turns with sufficient rapidity to produce an appreciable oscillation, the frequency of which, on the one hand, can be varied by the number of turns of the apparatus, the amplitude by an eccentric that can be longer or shorter, as required, and the force by a more or less heavy weight.

M. Charcot proposes to try this casque for sick headache, for certain nervous conditions accompanied by pain, and for certain mental conditions accompanied by depression. Ten patients suffering from disorders of this kind, whom we have ourselves, with the assistance of Dr. Gilles de la Tourette, subjected to this treatment, have sufficiently recovered to lead us to hope that we may be able to relieve those maladies which, at present, are beyond the reach of medicine.

Moreover, very shortly, Prof. Charcot will give a lecture on the subject at the Salpêtrière, and will state his ideas with regard to this mode of treatment, to which he attaches a certain degree of importance, and which, I believe, I have placed before you as something as yet unknown to the public.

M. J. P. Michaels related that when experimenting with the electric rod diapason of Dr. Boudet de Pâris, he was able to produce local anæsthesia, by applying the button of the apparatus to the gums, half-way up the roots of the teeth, and to perform one of the most painful of dental operations, that of extracting the living nerves from the teeth, without the patient feeling any pain.

This action was due to the mechanical vibration which, by numbing the nerves, lessened their sensitiveness.

One of the first effects noted by the employment of a vibrator, was a local anæsthesia, sufficiently pronounced for the prick of a needle to be no longer felt. M. Michaels's experiments show that this anæsthesia is pretty deep, since it has enabled him to perform dental operations without pain.

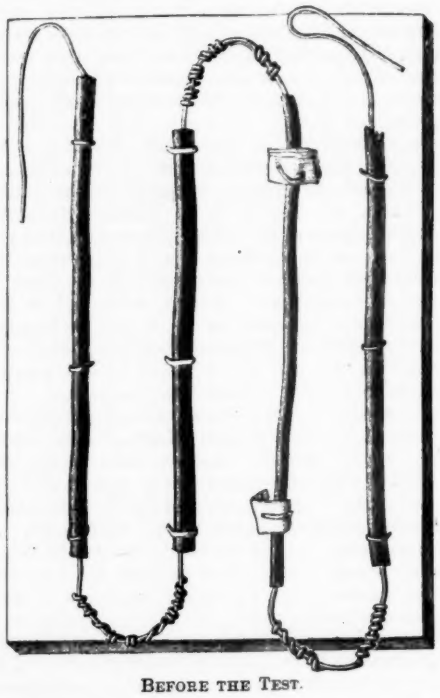
TEST OF FIREPROOF WIRES.

MESSRS. WASHBURN & MOEN, through their representative, Mr. C. T. Snedekor, recently gave an exhibition of the remarkable fireproof qualities of a new brand of insulated wire manufactured by them. The exhibition or test took place at the Pearl Street Edison station, in this city, in the presence of the insurance electrical inspectors and experts, who adjourned their meeting to attend. Several other well-known insurance men and a number of electrical experts were present, and everyone seemed highly pleased with the test.

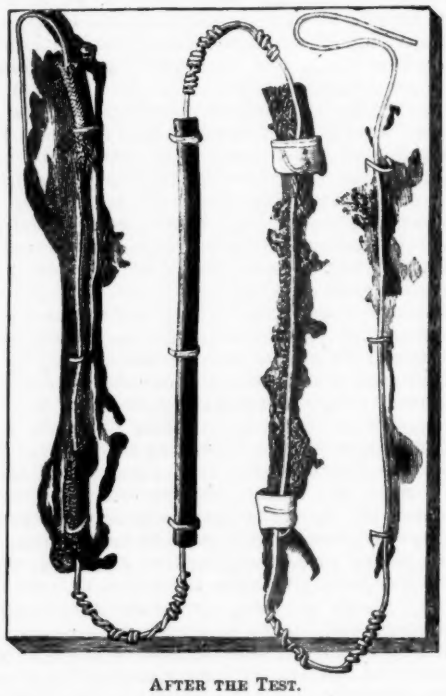
From two to four 6-inch lengths of various wires, one always being a sample of the Washburn & Moen "Salamander" fireproof, as the new wire is called, were fastened parallel to each other in series on a smooth board and a powerful current sent through and maintained until the insulation of one or more of the wires was destroyed, or until one of the wires fused.

One of the first tests, says the New York *Electrical World*, was between a sample of a standard high grade house wire and the same kind of wire covered with the fireproof compound. The wires were 14 B. and S., and after being subjected for three minutes to a current increasing from 25 to 150 ampères, the wires becoming white hot, the insulation of the former was entirely destroyed, while the exterior of the latter remained firm and comparatively cool. An examination after the wire had cooled demonstrated that the "Salamander" had excellently protected the first or original covering of the wire on which it had been used, whilst the insulation not covered by "Salamander" was so entirely destroyed as to leave the wire practically bare.

Some competitive tests were made with 12 different well-known brands of wire, and in every instance the insulation of all except the "Salamander" brand was either entirely destroyed, or so deteriorated, as to be useless. In some instances the current was kept on until one of the wires was fused, or until the board to which they were fastened was set on fire, but in every case not sufficient heat escaped through the "Salamander" coating to discolour the board underneath it. Under the intense heat all of the wires, except the "Salamander," blazed more or less, including several specimens of fireproof wires, so-called. The rubber, or other first coating of the "Salamander" wire, seemed to undergo very little deterioration from the great heat.



BEFORE THE TEST.



AFTER THE TEST.

The illustrations show a board of wires before testing, and the same after being subjected to a current of 150 ampères.

Mr. Snedekor exhibited a report of tests made by the Massachusetts Electrical Engineering Company, which showed that after an immersion of 26 hours the insulation resistance of 260 feet of "Salamander" fireproof No. 16 B. and S. was equivalent to 880 megohms per mile.

SAMUEL ALFRED VARLEY.

IT is doubtful whether there lives to-day a man who, considering what he has accomplished, is so little known as Mr. Samuel Alfred Varley. His work has never yet been properly separated from that of his brothers. It is not that Varley was very intimately associated in scientific labours with his brothers. He alone carried out the experiments which led to his inventions. Up to the day of his death, the figure of Mr. Cromwell Varley was familiar in electrical circles; this, no doubt, together with the fact that Mr. Samuel Varley rarely mixed or held communication with electrical people, had much to do with his abilities receiving little recognition.

It is hoped that this article will enable living electrical men to see for themselves what the real value is of Varley as an inventor, and to appreciate from the following record the work he has done.

Samuel Alfred Varley was born in London in 1832, and is the third son of the late Cornelius Varley. Cornelius Varley had acquired a knowledge and a taste for science in the laboratory of his uncle, Samuel Varley, but he afterwards followed the Arts, and became distinguished as a painter in water colours. He was one of the original members and founders of the Old Water Colour Society.

The Samuel Varley mentioned did much no doubt to awaken the scientific aptitude of the Varley family. In his day he was a leading scientist, and a small body of scientific men and patrons of science, of whom Josiah Wedgewood, the art potter, was one, formed a society, which held its meetings in the laboratory of Samuel Varley. The members of this society afterwards founded the Royal Institution. Samuel Varley was invited to become the first professor, but declined. At a later date, he consented, after much persuasion, to enter the service of Earl Stanhope, a great patron of science, where he remained until the death of the earl, who bequeathed to him his scientific library, his tools and apparatus. Some of this apparatus becoming, eventually, the property of Cornelius Varley. They became the playthings of the family, and no doubt did much to inculcate a love of science.

It is not necessary to say much here concerning the brothers of Samuel Alfred Varley. The late Cromwell Fleetwood Varley was perhaps the best known member of a family which has been famous in scientific history for a generation. He was one of the leading electrical men in the early days of electricity, and was, during the later years of his life, a partner with Prof. Thomson (Lord Kelvin). There will be occasion, in the course of this short sketch, to refer to some of Cromwell Varley's work.

From a photograph [*by Maull & Fox.*

SAMUEL ALFRED VARLEY.

The childhood of Samuel Alfred Varley was remarkable for its rare simplicity. He was reared in a household which had much of the old-fashioned about it; but it was an old fashion which proceeded from a love of truth, a devotedness to rectitude, and a desire to live simply and naturally.

Domestic peace and quietude are qualities well suited to the pursuit of scientific knowledge, and amid such surroundings the elder Varley endeavoured, hand-in-hand with a knowledge of the Bible, to impart scientific truth to his sons. The family belonged to a religious body renowned for its connection with Faraday. It was a sect composed of the followers of Dr. Sandeman, a seceder from the Presbyterian Church. To the meeting house of this simple-minded congregation Samuel Alfred Varley when a very young child was taken regularly; Faraday being at that time, an elder. Varley was taught to look upon him as a religious teacher and a great scientific man. Naturally there was instilled in the mind of the child an early reverence for Faraday, the effects of which were felt through life. And in all times there is surely no figure which, for its uprightness and singleness of purpose, could command a greater tribute of reverence than the great and good man, Faraday.

The day's religious duties over, the rest of the Sunday was commonly devoted to scientific experiments. Then came the frugal evening meal, the Bible was read for a while, and the day was brought to a close by singing some of the grand old hymns.

To the mind of a child thus brought up, religion and science must have been indissolubly associated; the elucidation of scientific truth became a consecrated duty. A noble purpose with which to begin life's battle.

Of Varley's early knowledge, much was gained in his father's studio. His father, while working at the easel, would quote poetry, the child following in a book the printed words. He acquired by this means the ability to read at a very early age About this time he developed considerable drawing powers, which led the elder Varley to hope that he would one day become a skilful painter. But the drawing faculty became exhausted before the child had reached his seventh year. At the age of eight he was sent to St. Saviour's Grammar School, Southwark, where he remained until his fourteenth year. As a child he was too much given to scientific speculation to take an active interest in routine school work. It is not surprising, therefore, to find that on leaving school he immediately entered into scientific researches. Magnetism appealed to him strongly, and after much experiment he formulated in his own mind a theory of magnetism which of late years he has developed more fully. He was, however, induced to lay aside his magnetic experiments and turn his attention to voltaic

batteries. Between the years 1846 and 1849, he made several hundred Grove's cells for his brother Cromwell, which were intended for electric light experiments. The trouble attendant upon battery manipulation led Samuel Varley to turn to magneto machines as a more hopeful source of energy.

The Saxton machine of that period was a heavy machine, giving comparatively poor results. This want of efficiency seemed to Varley to be owing to the length of the iron armature in which the reversals occurred, and to the middle portion, which was the most active, not being wrapped with convolutions of insulated wire. Thus reasoning, he designed a magneto machine in which the field magnets consisted of bundles of magnetised tempered steel wires, the revolving armatures being made of laminated iron wrapped in the middle. The construction of this machine was commenced when Varley was 17 years of age, but his efforts met with so little encouragement that the machine was afterwards abandoned. It is much to be regretted that Varley's work met with so little appreciation, for no doubt his machine would have been a distinct advance on the magneto machines of the period.

But he did not long remain a private experimenter, for in 1852, he entered the Manchester workshops of the Electric Telegraph Company.

At this time there prevailed great activity in the direction of underground circuits. Underground wires were actually being laid. Cromwell, the elder brother of Samuel, was opposed to the adoption of underground circuits, for the reason that induction would be so great that it would interfere with signalling. He was convinced of the reasonableness of this supposition by some experiments which he carried out with the assistance of Samuel on ten miles of wire immersed in tanks. The opinions, however, of the elder Varley, were considered visionary, and the work of laying was continued. The predictions of Cromwell were more than amply verified. Faraday was asked to devise some means of getting rid of the disturbing element, but there was no remedy forthcoming until Cromwell Varley proposed his double current system.

While this may seem somewhat of a digression from the main purpose of our brief summary of the life of S. A. Varley, it will serve to show some of the problems which, remote as they appear to us at the present day, perplexed the minds of the electricians of those days.

The man in charge of a telegraph district, needed in those days to be something more than a mere trained engineer. The capacities required of such a man at the present moment need not be so great, but at that time there was no experience to fall back upon, no old and tried engineers ever ready to help a younger *confrère* over a difficulty. Constant recurring phenomena, which threw a whole circuit out of order, had to be met out of the resources of the engineer in charge. It was an ordeal, however, which if a man came through, proved him to be an electrician to the backbone. Telegraphy in those days was a new branch of science, struggling hard to maintain its footing as a practical workable thing. Much is due to the men who kept it upright; pioneers as they were, they led the way to a practical working and a knowledge of electrical matters. Dwarfed by time as the labours of these men may now be, antiquated as their notions may appear to the new race of electricians, they carried out experiments and perfected inventions which are often claimed in the specifications of to-day. The men of that time were a race of scientific giants, whose magnanimity forbade them to seek out of scientific work personal gain. This is one phase of the matter in which no favourable comparison can be made between the electricians of 1852 and their successors of 1892.

S. A. Varley, in 1854, had engineering charge of the Liverpool telegraph district. The responsibility of such a post is, now-a-days, difficult to realise. About this time the first long-distance time-ball in connection with Greenwich was erected in Liverpool. For some reason or other, the arrangement worked badly. A discussion arose in the public press, and Varley was called upon to make the apparatus work. He succeeded, at the same time designing an electric chronograph, probably the first of this class of instruments ever made, by which he measured the loss of time in the discharging apparatus, as well as the time occupied by the signal in travelling through an underground wire from London. The apparatus which discharged the ball was also designed to send a signal back to London. The interval of time between signalling from Greenwich and the dropping of the time-ball was $\frac{11}{20}$ths of a second, $\frac{5}{20}$ths of a second being consumed in the passage of the signal through the underground wire, and $\frac{6}{20}$ths of a second in the London and Liverpool apparatus. Such an accomplishment is nothing extraordinary, but it made a great impression in 1854. The experience gained on the Liverpool time-ball enabled Varley some years later to construct apparatus for India, China, and elsewhere. There is every reason to believe that in most cases the apparatus is still working.

The year 1854 was a remarkable one in the history of electrical science. The knowledge of the science was then in the hands of a few earnest men. But that year saw many great applications of electrical science; in fact, it marks the beginning of practical applications. Underground circuits of considerable length were first inaugurated, the first long distance time-ball was erected, the double current system was first introduced, and in this year the first papers on practical telegraphy were read before the British Association by Cromwell Varley, and Edward Bright, and at the same meeting, Dr. Wildman Whitehouse (one of the projectors of the first Atlantic enterprise) presented a communication on signalling through long submarine circuits.

With the advent of the Crimean War, there sprang into existence a power which had never before been met with in warfare—the field telegraphs. Previous to the Crimean campaign, all news from the seat of war, all communications between the operating army were mostly conveyed by mounted messengers; the messages, uncertain in delivery, frequently failing to reach their destination.

The War Department were not slow to recognise the utility of the telegraphs, and after communications from the War Office, Mr. Varley was appointed the chief of the first field telegraphs. Although in feeble health the greater part of the time he was in the Crimea he was never absent from duty; he was present at the battle of Tchernayah, and the evacuation of Sebastopol. On the armistice being signed, Varley left the Crimea to take charge of the Varna and Constantinople cable. In October, 1856, at the completion of the Paris Treaty, by which peace was restored, he returned to England.

It was then that the scientific advisers of the Atlantic Telegraph Company were exercised, among other things, with the question of the size of the conductor. They had determined, by costly experiment, that conductors of small section would transmit signals more rapidly than conductors of larger section. These views were generally accepted, and Faraday went as far as to give an explanation before the Institution of Civil Engineers of the reason small conductors transmitted more rapidly than larger conductors. Instinctively, as it were, Varley felt that such a conclusion was erroneous. He communicated his doubt to the elder Varley (Cromwell), but found that he was in entire agreement with the conclusion of the scientific advisers of the Telegraph Company. Samuel Varley set to work to elucidate the matter, and after much study and experimenting, detected the source of error. Not only did he put the matter in a clear light, but he demonstrated, also, the general principles underlying rapid transmission.

In February, 1858, the subject of Atlantic telegraphy came up for discussion before the Institution of Civil Engineers. With an invitation to Varley to take part in the debate, came the opportunity of stating his views and the conclusions arrived at from experiment. The weight of argument completely satisfied the engineers present as to the correctness of his experimental results. Mr. Locke, then president, Robert Stephenson and Prof. Graham were warm in their commendations of his work. There was for Varley a still greater triumph, and a further vindication of his views. Faraday, with a magnanimity worthy of such a man, acknowledged, in a letter, the accuracy of Varley's views, thereby admitting the fallacy of his own opinions uttered some 12 months previously.

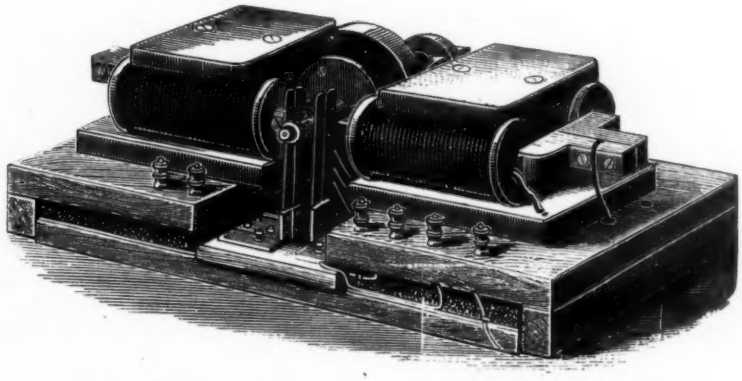
The paper read before the Civil Engineers was followed by a communication to the Society of Arts on the practical bearing of the theory of electricity to long submarine electrical circuits. In this paper appears the first description of artificial submarine circuits. By the aid of these circuits the longest submarine cables have been duplexed. This paper, reproduced in most of the technical journals of the period, formed the subject of journalistic discussion in the columns of the *Engineer*, lasting for several weeks. Shortly after

Samuel Varley read these two papers, his brother Cromwell was appointed chief-engineer to the Atlantic Cable Company.

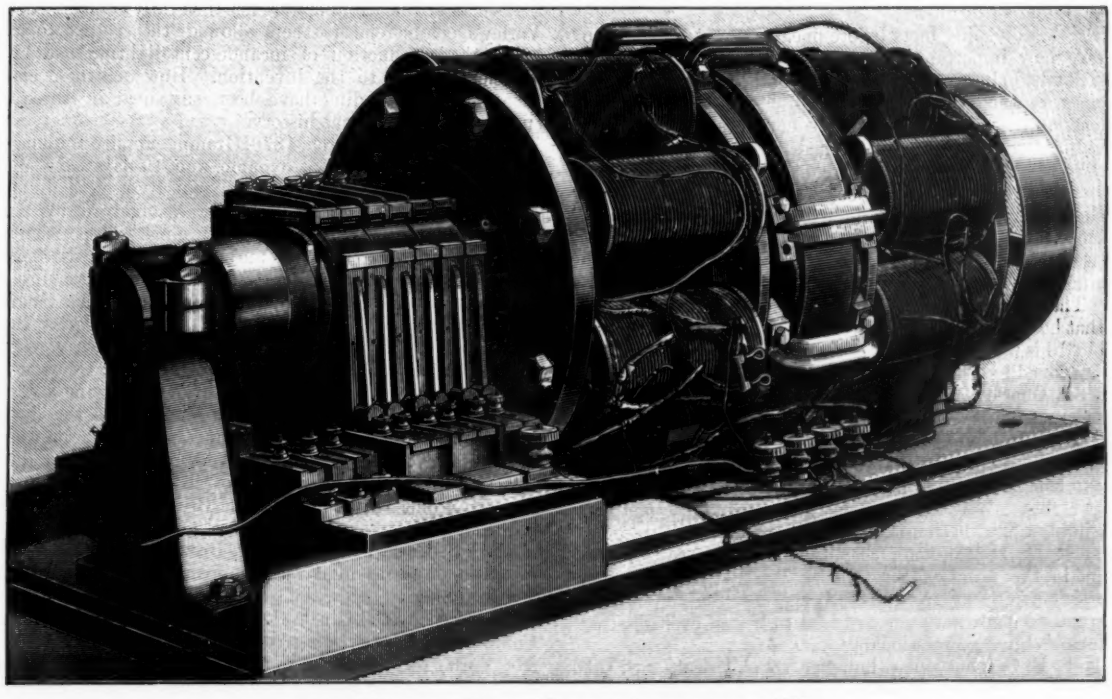
In 1859 Varley re-entered the service of the Electric and International Telegraph Company, as engineer of the London district; it was during this year that Cromwell Varley designed the first of the symmetrical influence machines. This is an interesting fact, because it had an indirect bearing on the future dynamo. It was this machine which awakened in Samuel Varley the desire to make a machine which would do for dynamic electricity what his brother Cromwell's did for static electricity. Unfortunately, he was unable at that time to work much on the original idea, for two years later he was persuaded to resign his appointment as engineer to the London district in order that he might take the management in a manufacturing business inherited by his father, who at that time was an old man, over eighty years of age. Perhaps this was the most unfortunate step in the whole of Varley's life.

It was not until the year 1866 that he was able to complete some of his inventions which had occupied his attention for some years previously. An important invention at this time was an improved construction of needle telegraphs, which were made of soft iron rendered magnetic by permanent magnets outside the coils, and, therefore, undemagnetisable. The coils of these instruments were protected from being fused during thunderstorms by a novel form of protector, being, in fact, a lightning bridge. This constructive advance on the Cooke and Wheatstone instrument was referred to in the Postmaster-General's report as the greatest improvement in needle telegraphs since their introduction. The second invention at this period was the self-exciting dynamo, the first machine made with soft iron magnets. The third invention was a system of electrical communication for signalling between passengers, guards and drivers in railway trains.

It was unquestionably the intention of Varley in this year to have completed his dynamo in time to permit him to read a paper at the Nottingham meeting of the British Association. With this object in view, he worked hard for the consummation of the principle of the dynamo. When he appeared to be in a fair way to declare his invention to the British Association, he was called upon to fit up his system of train communication on the Royal train in which Queen Victoria was to proceed to the North. Varley accompanied the Royal train to Scotland, proceeding direct from there to Nottingham, where he arrived on the eve of the last day of the meeting. Work of fitting up the Queen's train had thwarted his original plan of reading a paper to the Association. But, disappointing as this was, he felt so confident of the ultimate success of his machine, that he mentioned the matter to Prof. Harley and Mr. Russell, the mathematician, both of whom were present at the meeting. So impressed was Mr. Russell at what he heard,



VARLEY'S ORIGINAL DYNAMO, CONSTRUCTED IN THE YEAR 1866.



VARLEY'S COMPOUND-WOUND MACHINE, CONSTRUCTED IN 1876.

that he strongly urged Varley to read a paper as soon as possible before the Royal Society. This was sound advice, and had Varley made haste to accept it, his claims as the originator of the dynamo principle would have stood absolutely unquestioned. There was ample excuse on Varley's part for not having acted on Mr. Russell's advice; 1866 was the year of the panic, and Varley, as well as thousands more, was involved in considerable pecuniary loss.

Before proceeding further upon the matter of Varley's claims as an inventor of the dynamo principle, it is worthy of mention that Sir Charles Wheatstone was, at the B.A. meeting referred to, President of the Mathematical Section. In his Presidential address there is, curiously enough, no mention made of so important a matter as the production of his dynamo. This fact will be dwelt upon a little later.

Varley's dynamo, now in South Kensington Museum, was completed at the end of August, or the beginning of September, and was immediately shown working to Varley's friends. There is still living a workman who helped to make this machine. The provisional specification was not lodged until December, some months after the completion of the machine. It is, perhaps, worth mentioning that this specification is taken out in the names of Cornelius and Samuel Alfred Varley. This is simply due to the fact that Cornelius and Samuel were at the time in a commercial partnership. But it was pointed out earlier in this article that Samuel Varley had resigned his engineering post in order to take control of his father's business. Cornelius had ceased to take active part in business, and, save in a commercial sense, he was in no way responsible for the patent. It has come within the author's experience that the dynamo of Varley has been sometimes spoken of as the joint production of Cromwell and his brother. Such an error has probably arisen from the fact that the initials only of the patentees have been used, thus causing confusion between Cromwell and Cornelius.*

With the foregoing facts before one, it is not difficult to conceive how important was the advice of Mr. Russell. The delay had simply proved fatal to Varley's claims as the originator of the dynamo principle.

Although there are many who are convinced that Varley was unquestionably the man who had first in his mind the principle of the dynamo, there are others who have shown scant respect to his claims. Books, professedly written as a complete history of the dynamo, pass over his work almost in silence.

It seems to be absolutely certain that Varley worked on his machine some months prior to the British Association meeting. That it was nearly completed is vouched for by the fact that he mentioned the matter to Mr. Russell, and that he exhibited his machines in August or the early days of September, is proved by the testimony of his friends.

As Sir Charles Wheatstone was president of the Mathematical Section, it is curious that he missed the opportunity of referring to his discovery. It may be said that patent rights precluded him from speaking upon the subject. The reply to this is that Sir Charles was absolutely indifferent to patent rights. Why then did he not refer to the matter? The simplest explanation is, that when the British Association met at Nottingham, the dynamo principle was not present in the mind of Sir Charles Wheatstone. Another important point is, that while both the machines of Wheatstone and Siemens were not designed to be self-exciting, that of Varley's most unquestionably was.

Mr. T. E. Gatehouse has, however, so ably dealt with this celebrated dynamo controversy in his "Strange History of a Dynamo," that the subject would gain little from further comments here.

The Railway Regulation Act of 1868 had decided that some system of electrical communication should be adopted on all trains. For the purpose of complying with the clauses of the Act, a great trial of systems took place at York. Of all the systems which took part in the trial, Varley's was the only one which completely fulfilled the conditions of the Act. He was informed by the manager of the London and North Western Railway that he might look forward to the work of fitting up all the railway trains north of England. Misfortune, however, still dogged Varley's footsteps. The Conservative Government went out of office; the new President of the Board of Trade, John Bright, gave to the railway companies a provisional consent to use the cord. This consent was afterwards withdrawn, but the railway companies continued to use the cord, and do so at the present day, in defiance of the Act of Parliament.

The Telegraph Bill of 1869 made the telegraphs a Government monopoly. With it came the power to make or mar a telegraph manufacturer's apparatus. There is no need to enquire closely into the manner of doing this.

It was previously mentioned that the undemagnetisable instruments were much eulogised in the Postmaster-General's report, but they were not spoken of as the inventions of Varley. The impression was allowed to go forth that it was an improvement which had emanated from the Telegraphs Department.

The lightning bridges made by Varley were adopted by the Post Office, but were afterwards condemned. They were condemned because the bridges had no direct earth connection. Now, it was an undeniable fact that these lightning bridges were not constructed with an earth connection, because of a regulation of the Post Office, which was insisted on, and which did not permit Varley to make earth connections.

Soon after the telegraphs became a Government monopoly, Varley was compelled to close his works. Thirteen years had been necessary to build up a prosperous business, which in a brief time had become valueless; a cause which can be distinctly traced to the action of the Post Office.

Shortly after the closing of his works Varley's health gave way, and for some years he was more or less an invalid.

In 1874 Mr. Varley became assistant manager of the British Telegraph Manufactory, and two years later patented a series-shunt or compound-wound machine. Unfortunately, the merits of the machine were not then fully appreciated, and Varley's commercial partners allowed the patent to lapse before the introduction of incandescent lighting had given commercial value to the invention. How well these claims for compound winding have been sustained in three law suits is matter of recent history.

In the month of March, 1878, Gramme applied for a patent for an alternating current dynamo, and 19 days later Wilde lodged a patent for a similar machine. By a method known as racing the seal, letters patent were obtained by Wilde before they had been granted to Gramme. Opposition was then lodged against Gramme's claims, and the matter was taken into the law courts. Rather than undergo the uncertainties of English law, the proprietors of the Gramme patent had resolved to abandon the defence. Varley intervened, advised on the defendant's side, and they resisted Wilde's claims. When the case was called into Court it was allowed to go by default, the plaintiff Wilde paying all costs.

In 1885, Varley was consulted in reference to the lawsuit of Brush *v.* Crompton & Co. Reluctant though he was at first to take part in a legal controversy, he resolved to do his best to release the industry from royalties. But the lawsuit was compromised in favour of the Brush Company. Varley then called upon the trade to assist him in upsetting the claims of Brush. Messrs. King, Brown & Co. accepted the invitation, and the fight was commenced in the Scotch law courts. Shortly before the case came on for hearing, terms were offered by the Brush Company, and King, Brown and Company's legal advisers recommended their adoption. But Mr. Varley was successful in preventing the compromise, with the result that the Brush Company's claims were resisted in two Scotch courts; and, finally, the House of Lords, without hearing defendants' counsel, gave a similar verdict.

In all probability a compromise would have resulted in the Brush Company obtaining a prolongation of their patent for seven years, dating from May, 1892.

And now that the principal work of Varley's is upon record, we may be allowed to take a rough measure of its value.

Mr. S. A. Varley, through his father (born in 1781), and his father's foster parent, Samuel Varley, reaches back to a period antecedent to that of the discoveries of Galvani, Volta, and Oersted, which were made in 1790, 1800 and 1819 respectively. He has seen nearly all the useful applications of electricity made during his lifetime. He pioneered and constructed in the early days of telegraphy; he had charge

* A similar error arising from the same source has been met with in other inventions of Varley. The lightning bridge and the undemagnetisable apparatus were often spoken of as joint patents of Cromwell and Samuel Alfred Varley.

of the first field telegraphs ever used in warfare; it fell to him to lay bare the errors of the Atlantic Telegraph Company's advisers; he invented and made the first artificial submarine cables; the one great improvement on Wheatstone's needle telegraph instrument was designed by him, and in 1866 he discovered the dynamo principle, and constructed the first self-exciting dynamo, following this, 10 years later, by his compound-wound machine.

Through his intervention in the Gramme case, the manufacture of dynamos was thrown open to the industry. His compound machine stopped the exaction of royalties by the Brush Corporation. This, the last of his labours, received legalisation in the House of Lords on April 5th of this year.

His whole life has been spent in the service of science, yet what is his position to-day? The value of his inventions are undeniable, yet what is his gain? There never was a man in the whole history of invention who obtained less from his genius than Samuel Alfred Varley. There never started on this life a man with greater hopes of his accomplishments. New men have entered the electrical world and speedily become enriched. Varley has toiled nigh fifty years, and to-day is but a poor man. But perhaps the greatest misfortune to him is that his work has received scant recognition.

The fact that Varley did not reap pecuniary advantage from his early invention is a misfortune to the nation. A fair competence would have enabled him to devote his great endowments without intermission to the service of science.

H. S.

THE TELEPHONE.

MR. F. FAITHFULL BEGG writes in the *Times* of the 3rd inst. on the subject of the Duke of Marlborough's letter of the 20th ult., and confining himself to a point arising directly out of the previous correspondence between them, says:—

> The correspondence turned upon the question of cost, the position taken up and adhered to by the Duke being that "a complete twin-wire telephone service for the whole of London" could be carried on at a remunerative profit on the basis of a £10 rental. This conclusion I challenged, and asked for demonstration in figures, which was not supplied. What is his argument now? He says that, "though a lower scale of charge might have been produced by competition, the eventual cost to the public, and also to the shareholders, would have been considerably greater."
>
> Comment is needless. The truth is that the more the Duke of Marlborough studied the telephone problem, the more clearly he came to see that those into whose hands the management had at last fallen, and with whom he is now associated, knew what they were about, and were competent to give an efficient service, with a due regard to economy, which is exactly what I contended for.

To this the Duke replies in a long letter, published on the 6th inst., from which we extract the following:—

> We are not where we were last year when our last tournament took place and Mr. Begg appeared on the scene as the champion of the National Telephone Company. Then the lion reared at the lamb and pretended to treat that humble animal with contempt and devour him. To-day the lion is good enough to lie down with its despised brother, and is only too pleased to have been able to construct a happy family!
>
> The Telegraphs Bill did two things which the lion would have been very glad to have seen left alone. If the lion had not, in a totally unprovoked manner, roared at the lamb, I should not say these things, but, as the truth had better be told, the enemy, "our present friends," were placed in an awkward position. Their entire system is a single-wire system, and useless to talk over the Government trunks on. The lion thus observed that the lamb might possibly at a not distant day grow up to be a dangerous rival lion, who might divide the British Isles with the older animal. Prudent counsels came into play. Private friendships and mutual appreciation between individuals connected with both interests promoted peace. There was no desire on my part, so far as my influence in these matters had any weight, to rush into a furious contest, and perhaps have to work myself into fiddle-strings to carry on the contest which was inevitable. The lion has had to climb down along a very comfortable road we have made for him, and along which we propose to proceed together, if possible, as very good business friends.
>
> Mr. Begg suggests that I had bleated a good deal about a £10 telephone. No doubt I have. Had we gone into rate-cutting as between the two companies we would probably have come to this, and I still maintain that it is quite possible that, as the industry increases, a considerably lower rate may be practicable. But, though I did say a good deal more about a lower rate, I said a great deal, also, about efficiency. It is no doubt convenient to Mr. Begg to avoid allusion to this question. Now, I venture to believe I know as much about the telephone as any of the gentlemen connected with the old National Company, and perhaps a good deal more, or the New Telephone Company would not to-day be a going concern. What the public do not understand, but which experts comprehend, is the fact that the entire telephone system throughout all the large towns of England has to be redone from end to end before a trunk system can be made to work efficiently. No wonder, then, the two telephone companies have adopted the very reasonable course of endeavouring to carry out this work in harmony instead of wasting their energies in fighting rival systems in every town, to the discomfort and confusion of subscribers. In order to bring about these results a reasonable time must be given to the companies, but it is foolish for the public to suppose, as some persons would wish to lead opinion, that the New Telephone Company is in any way a dependency of the National Company, or that the National Company have swallowed up the New. It is no concern of anybody's except the shareholders in the two companies what the commercial arrangements and division of work will be between the two corporations.

It is interesting to observe the continuance of this controversy by the champion of "those into whose hands the management has at last fallen," and the knight errant who maintains that "the lion has had to climb down." The combatants are surely mistaken in supposing that the public have any interest in the purely personal question as to which side is entitled to be considered the victor in the autumn manœuvres of last year or this year. The public may be amused at the meekness and modesty of the Duke of Marlborough in identifying his company with a lamb and assuming personally to know as much about the telephone as those who have been conducting the business for some years. We cannot, however, agree with the Duke that it is no concern of anybody's except the shareholders what are the commercial arrangements between the two companies. Had the Duke of Marlborough assumed in the public prints the position which he assumed as chairman of the Pioneer Telephone Company, and admitted that the primary object was commercial profit, and the secondary object the public advantage, we quite agree that it would have been no concern of anybody's, but that was not the Duke's public attitude, and, in consequence, it is not surprising that some concern should be shown at the manner in which—as the frank avowals of some of our contemporaries show—the public have been misled. It seems to us that it would be altogether undesirable for the evident change in the arguments of the Duke of Marlborough to pass without comment.

THE "BRAIN" SYSTEM OF ELECTRICAL TRACTION.

THE overhead trolley system, which has been so successful in America, has thoroughly established the fact of the "economy" of electrical traction when operated by means of a direct connection to a line conductor, but the inconveniencies and objections to the exposed overhead wires prohibit its use in most cities, certainly in this country. An underground conduit in the absence, at present, of any reliable and commercially practicable accumulator, is therefore the only resource.

Owing to difficulties experienced with those having an open slot, many proposals have been made for using a permanently sealed conduit with a series of short, exposed contact rails, and different methods for automatically connecting and disconnecting the contact rails and the main conductor; but none of these have been adopted; in fact, these closed conduit systems seem much more impracticable than an open slotted conduit.

The troubles experienced with the latter, which led to these proposed schemes, were the failure of the insulation during bad weather, and the frequent breakdown of the thin insulating covering on the travelling connection which passed through the narrow slot to the conductor. By increasing the size of the conduit and other proper precautions, the difficulty with the main conductor insulation can to a great extent be overcome. This, of course, entails a proportionate increase in the already large capital cost of a conduit; but the frequent failure of the thin insulating covering, so disastrous to the regularity of the traffic, can only be prevented by the use of a slot wide enough to allow a much thicker covering.

A wide slot, at least 1 inch wide, if not more, is therefore a *sine quâ non* to maintain an uninterrupted supply of power to the car from the conductor in the conduit. In this country the authorities will not allow it. Moreover, it necessitates a much wider and deeper conduit to accommodate the extra dirt accumulation, and prevent the exposure of the conductor, which again greatly adds to the cost. This is the only form in which the open slotted conduit can be made practicable; but the sinking fund on the heavy capital cost becomes a large item in the total working expenses, and the wide opening in the street is most objectionable. Further, the construction of such conduits requires a great disturbance and deep excavation in the roadway, and even then, the general inconveniences of these conduits, such as inaccessibility for repairs and renewals, the effect of ice and sleet in narrowing the slot, and many structural and working difficulties experienced with the conductor and the crossings, are still existing.

To summarise, the successful conduit must be primarily cheap, have a wide slot, and be small, thereby necessitating but little road disturbance. This is the practical issue of the past seven years' experience in street conduits.

The difficulty is to build such a conduit that would be unaffected by bad weather or dirt accumulations, and have a conductor never dangerously exposed. Now the system which is just being made public, known as the Brain "covered conduit," claims to exactly secure these advantages. It is the invention of Mr. C. T. B. Brain, of Bell's Buildings, South John Street, Liverpool, an engineer and electrician of long experience in this work. He was for some time electrician to Messrs. Elwell-Parker, and as engineer, has had responsible charges at the Portrush and Blackpool electrical tramways, where he successfully carried out various re-arrangements. He has proved the system by a series of trials extending over the past two years. His conduit is small and possesses a wide slot; this is covered by a continuous rail, formed of stout flat steel bars, joined end to end, and called the cover-rail, which sinks flush with the road surface and rests upon a ledge or flange on each side of the slot; thus excluding the dirt and preventing dangerous exposure of the conductor, which is placed centrally underneath the rail.

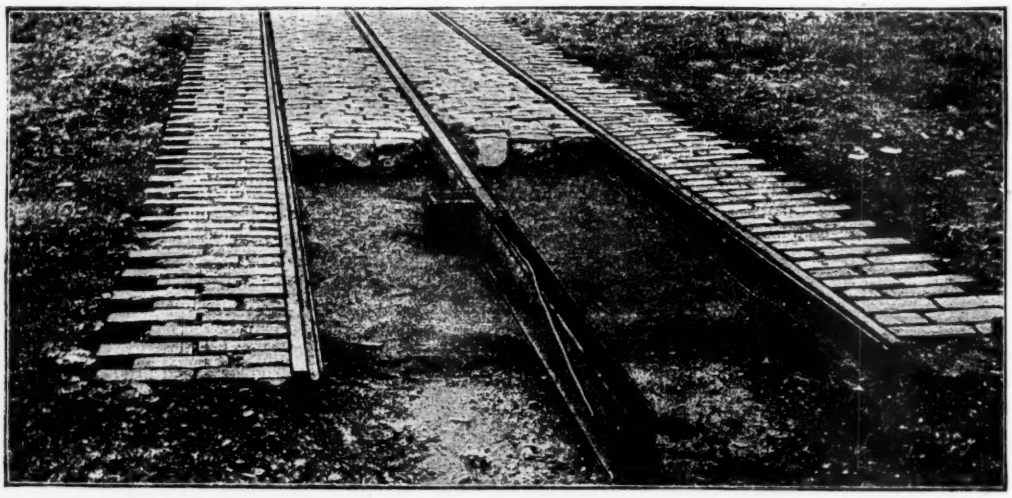


FIG. 1.

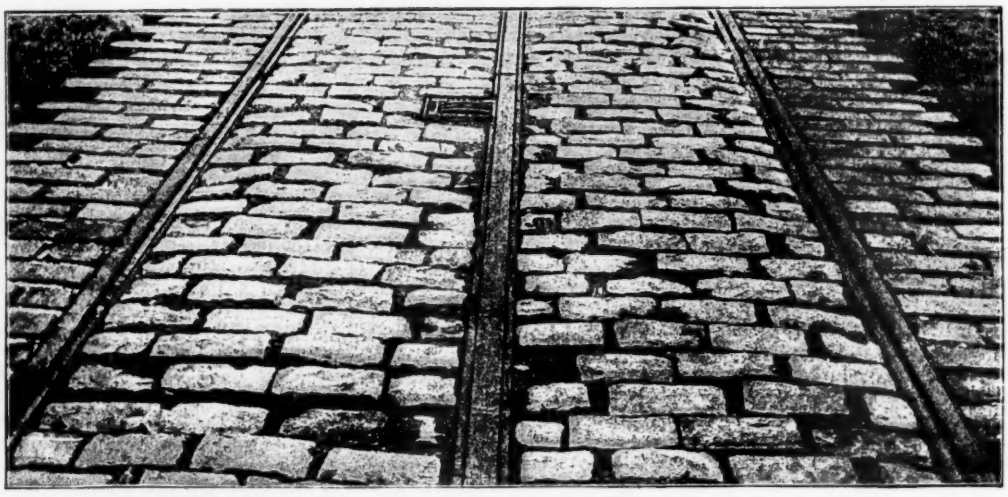


FIG. 2

Fig. 1 well illustrates the general construction.

It will be seen that the conduit consists of simple cast iron troughing, laid in lengths which firmly fit into each other upon the existing concrete of the roadway, this providing a ready-made and substantial foundation. To obtain access for the connection between the car and the line conductor in the conduit, the cover rail is held up about $1\frac{1}{2}$ inches high by rollers underneath it and connected to the car, which we describe hereafter in detail.

The most original and practical feature in the operation of this system is the manner in which so strong and heavy a rail returns to its seat on each side of the point of support. The cover rail is 2 inches wide by $\frac{7}{16}$ths inch thick, and such a stout bar has but a very small

deflection, returning to its seat at a distance of 4 or 5 feet on each side of the raised position. It is evident that with this section, and so short a width, the transverse strength of the cover is more than ample. It could bear many tons. Yet it has just sufficient flexibility lengthwise. As it does not weigh 3 lbs. per foot, the maximum *load* carried, due to the working of this rail, cannot exceed 3 lbs. × 10 feet = 30 lbs. Fig. 2 shows the neat appearance and unobjectionable character of the conduit on the road surface, and also gives a good idea how the conduit is protected from dirt and flooding. Owing to the depth to which the bedded rail sinks into the seat, and to its great rigidity in a horizontal plane, always retaining, even when raised, the shape in which it is fitted to the conduit, the action of the rail in returning to its seat is most certain, both on straight lines and curves. In practice, as a safeguard this is still further ensured by a roller near each end of the car running on the unlifted rail before and behind the raised portion.

The Collector Trolley.

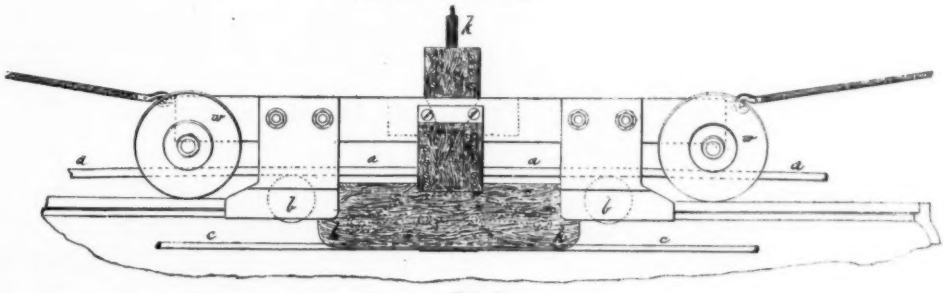


FIG. 3.

Cross Section through Centre. Contact Grip. Long. Sec. showing Contact piece

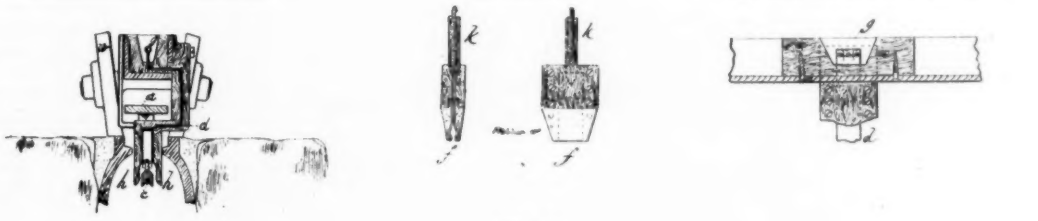


FIG. 4.

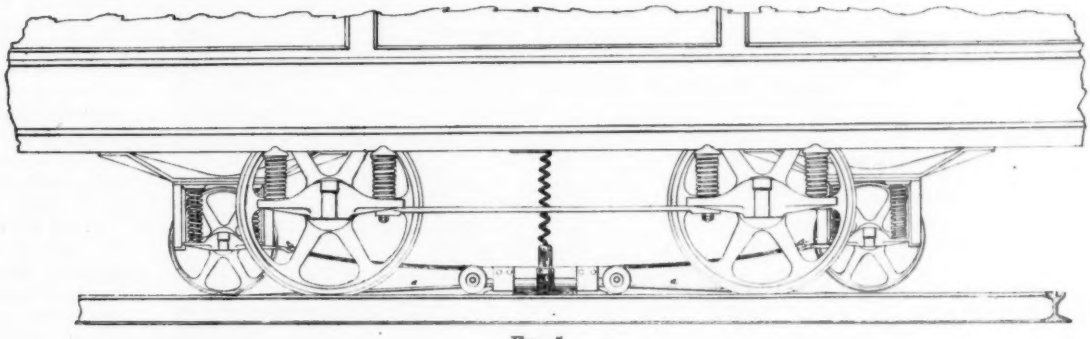


FIG. 5.

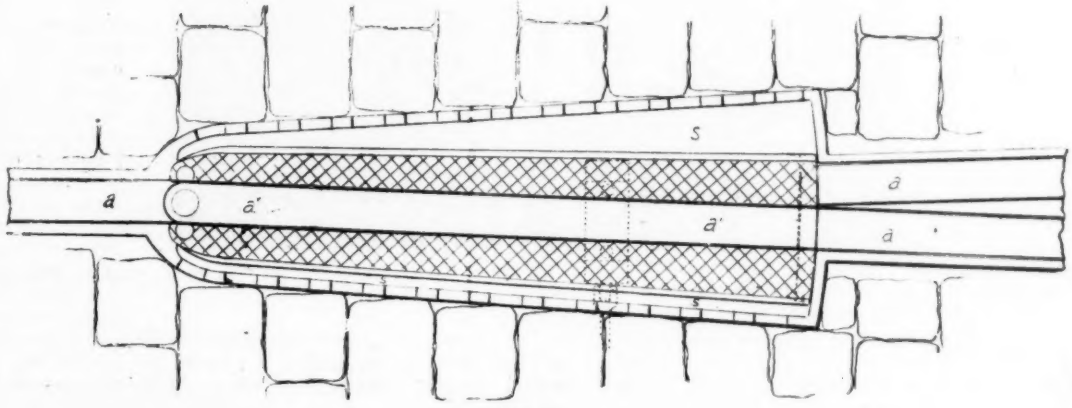


FIG. 6.

This travelling connection, with its sliding contact in the conduit, is called the collector. It is fixed to the brackets which carry the lifting rollers, there being two of these, one at each end of the collector, and they support the cover rail at C. The whole collector frame is in turn supported by a wheeled trolley, which runs upon the top edges of the conduit sides, A, A.

Figs. 3 and 4 are an elevation, and detailed sections of this collector trolley, in which *a*, *a*, is the cover rail; *b*, the lifting or carrier wheels; *c*, the conductor, and *d*, a flat conducting strip, which is the connection passing into the slot; *f*, a contact grip; *g*, the grip contact piece; *h*, the hard insulating block or collector case; *k*, flexible cable attached to car; *w*, trolley wheels. The trolley is drawn by ropes hooked to each end, and it will be seen that the connecting strip, *d*, is held in a position midway between the surfaces of the cover rail and conduit, and the insulation, already strong, is not subject to the heavy wear and friction. The insulating block, *h*, has let into it a thin steel case, like a lock frame, in which work the spring and strong levers attached to the contact shoe, shown in dotted lines. The grip contact is an insulated connecting plug, used as a convenient form of detachable connection. The car body and wheel base, together with the rollers running over the conduit, and the trolley in working position, are shown in fig. 5.

The flexure of the cover rail is so very slight, that the structure of the metal is in no way strained, its elasticity being so little taxed. The effort due to the operation of the rail is entirely confined to the weight carried and lifted. The weight carried is 30 lbs., and the rolling friction due to this requires a tractive effort of 1 lb. or 2 lbs. Taking the rise at 2 inches instead of 1½ inches, the weight lifted is 3 lbs. × 5,280 feet $\times \frac{2''}{12}$ = 2,640 foot lbs. per mile, or a pull of ½ lb., which, with friction, should also never exceed 2 lbs. The total power absorbed is therefore nominal. Even were the cover rail strained, there would be no tendency to hog up, as in being lifted and replaced both sides would be in turn stretched. The joints are made to allow a small sliding movement necessary for working and for expansion and contraction, and small fixed studs prevent the rail moving along the slot.

A considerable experience has been gained with the working of the rail which has thoroughly confirmed its practicability. Figs. 6 and 7 illustrate the way the cover rail is worked at the points or turnouts; *a*, *a*, *a*, show ends of cover rail. At the fork of the conduits the end of the rail covering the single line has fastened to it, by a stout pivot, a short length of cover rail, a^1 a^1, which can move like the points of an ordinary rail. The free end of this is grooved to fit tongues on the ends of the other rails, *a*, *a*, and can be moved into connection with the rail covering the conduit of either route. This is effected by pivoted cover plates on each side of it, which are fastened to a stout U-piece passing under the conductor inside the conduit, and shown in the section, fig. 7. They are made with a ledge on the inside similar to the conduit slot, and in these the rail, a^1 a^1, rests. To the U-piece is attached a rod, which controls the crossing. Where facing points are used, worked by hand, this is connected directly to, and therefore must work with them. But in turnouts, where the rail points are worked automatically by the car wheel flanges, a simple lever is placed in the groove of the rail, working this rod by the same means.

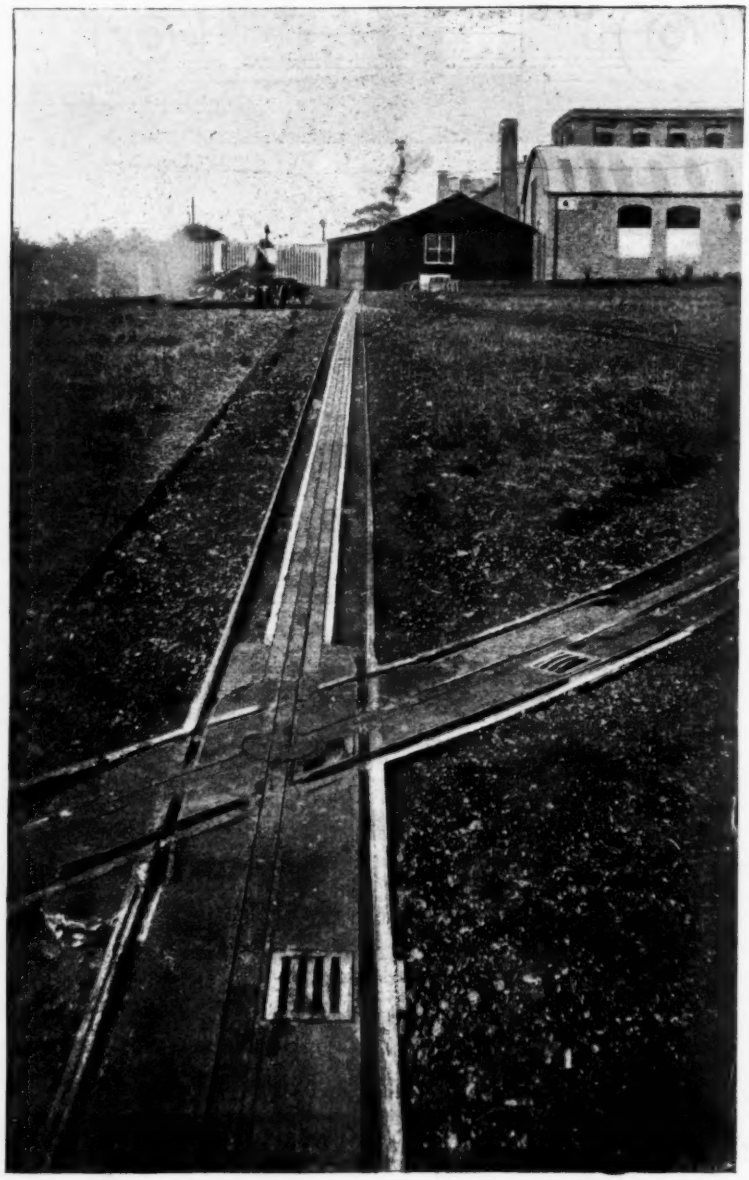


FIG. 8.

The pivoted side plates not only cover the large opening and support the rail, but tongue down the end of the rail of whichever conduit is not being used, and make the sides of the slot continuous in the direction they are turned, causing the passage of the collector to be as uninterrupted and certain in action as on a straight line.

It is here the greatest advantage is seen of a central conductor with contact made on its upper surface. At the turnouts, and all crossings the conductors can be made continuous, as at their junctions they are simply made to present a flattened surface, over which the contact shoe can easily slide in either direction.

In the account following of the practical work done with this system, a view is given of a crossing, constructed at a most awkward angle, in which the conductors are so fixed; and the cover-rail, which in this case has a short bit swung round by a U-piece, like a small turn-table, is actuated similarly to the above. All the parts have been developed and thoroughly tested during the past two years on a designedly awkward experimental line of narrow gauge track, but with full-size conduit, laid at the Britannia Works of the Telegraph Manufacturing Company, Limited, Helsby, who constructed all the plant to Mr. Brain's designs.

Moreover, all the various details and parts of the whole system have been worked out and reduced to standard patterns.

The experimental track was a long straight piece, on

which considerable speed was attained, terminating in a sharp curve of 25 feet radius, the line then continuing straight at a little less than a right angle for some distance, allowing the curve to be rapidly traversed in either direction. From off the straight length there was a turnout with points made as abrupt as possible; it winds round with curves of 35 to 50 feet radii, and passes right across the

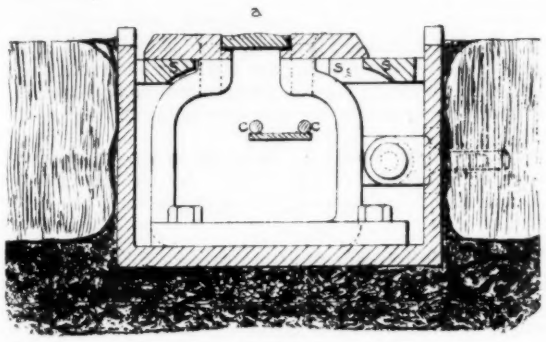


FIG. 7.

straight track cutting it at an angle of 45°; continuing, the lines join at the small curve, the two curved conduits meeting form a long, fine point.

Fig. 8 is the centre crossing with the small circular turning piece in the middle which operates the short connecting piece of cover rail.

In answer to an invitation, several gentlemen of the technical press have just lately visited this line and inspected its working, and tested the system in every way. Not the slightest fault or hitch could be seen, and they expressed great satisfaction.

Its small cost and mechanical simplicity seem to meet the requirements of the problem. The economy of working a conduit system has been proved; it is the objectionable slot and inherent faults of the line, injuring the traffic, which have prevented its adoption, even more than the great capital outlay required. But this capital involves up-keep, and it is now being realised that such engineering undertakings should have a sinking fund to meet the deterioration of the property. The percentage per annum required on this large capital depends very much upon the frequency with which the line has to be overhauled. This fund, as well as maintenance and repairs, is a part of the true working expenses, and the large proportion it becomes will be seen even in the case of Blackpool, where the conduit was built smaller than now found advisable with the open slot. It cost about £4,500 per mile, and this, at only 5 per cent., equals over 1d. per car mile run per mile laid—more than maintenance of fuel, the latter being 0·7d.

The simple construction and working movement of this "Brain" system make it most accessible for repairs. The cover rail, as it sinks in its seat, affords no hold on its surface for interference, but throughout its length can be easily and rapidly removed from its seat as fast as the car travels, by loosening a joint, setting the rail on one side, and putting the rear roller of the car out of place, so as to lay the cover rail on that side; running the car back replaces the rail.

In every way great economy appears possible with this system, and it warrants an extensive trial, which we cannot help thinking would rapidly lead to very important developments of electric tramway traction.

Electric Lighting in Derry.—Experiments have been going on at Derry for the past fortnight or more with the electric light for street lighting. The trials were attended with unusual success, and general approval and satisfaction is being expressed by a large number of persons who witnessed the lighting. According to the *Belfast Morning News*, the Corporation intended deciding the question whether electricity was to be adopted, at their meeting last Thursday.

NOTES.

Franco-Algerian Cable.—The *Petit Marseillais* says the first submarine cable is being laid between France and Algeria. About 15 miles of the cable has been laid from the African coast, and the work is proceeding briskly and satisfactorily.

The Theory of the Transformer.—The theory of the transformer forms the subject of an important communication to the Paris Academy of Science by Mons. Désiré Korda, in which he specially considers the introduction of a condenser into the secondary circuit. The treatment of this subject is of a too mathematical nature for reproduction in the ELECTRICAL REVIEW, and the paper is already condensed as far as is consistent with lucidity. Six of the formulæ given contain the general solution of the problem considered by Mons. Korda, and amongst other results he deduces the somewhat paradoxical conclusion that the apparent resistance is smaller than the ohmic resistance. Some of our readers who are fond of a little mathematical gymnastics may care to know that this paper is to be found in the *Comptes Rendus*, Vol. cxv., No. 7, pp. 331—334.

The Elihu Thomson Prize.—At the last prize contest instituted by the City of Paris for the best electric meter, the prize of 5,000 francs was awarded to Prof. Elihu Thomson. With the desire that this sum should serve for the development of the theoretical knowledge of electricity, he has requested the General Manager for Europe of the Thomson-Houston International Electric Company, to offer a prize for the best work on a theoretical question in electricity, and to organise a committee who should propose the subjects, examine the productions, and decide the prize. The following gentlemen have been chosen, and have kindly consented to act as members of the committee:—J. Carpentier, President of the Société Internationale des Electriciens; Hippolyte Fontaine; E. Hospitalier, Professor in the School of Physics and Chemistry of the City of Paris; E. Mascart, Member of the Institute; A. Potier, Member of the Institute, Examiner; B. Abdank-Abakanowicz, Consulting Engineer, Secretary of the Committee. The committee has decided that the prize should be given for an investigation on one of the following subjects:—1. The heat developed by successive charges and discharges of condensers under different conditions of frequency, nature of dielectric and quantity of charge. 2. It has been shown theoretically that when the two surfaces of a condenser are connected by a conducting body, the condenser becomes the source of alternating currents as soon as the resistance of the conducting body decreases below a certain limit. The formula that permits calculating the period of this oscillation has not yet been completely verified. This period of oscillation should be investigated experimentally under conditions such that the exact measure of resistance, capacity and coefficients of self-induction may be possible, in order to arrive at a complete and precise verification of this formula. 3. When a condenser made with an imperfect insulating material has been charged and then left to itself, the charge is gradually dissipated. The time necessary for the charge to be reduced to a given fraction of its initial value depends only on the nature of the insulating material. It is proposed to investigate whether, as certain recent theories would seem to indicate, analogous phenomena do not present themselves in metallic conductors, and whether these can be shown experimentally. 4. It is proposed to arrange and systematise our present knowledge of the graphical solutions of electrical problems, and deduce from them some general methods as in graphical statics. The theses presented may be written in any one of the following languages: English, French, German, Italian, Spanish, or Latin. They may be in manuscript, or printed. Each thesis presented must be signed by a pseudonym and accompanied by a sealed envelope bearing the same pseudonym on the outside, and with the name and address of the author inside. The papers must be sent before September 15th, 1893, to B. Abdank-Abakanowicz, consulting engineer, the secretary of the committee, at 7, Rue du Louvre, Paris, who will furnish any further information required.

Glasgow Electric Lighting.—It is said that the electric works in Waterloo Street, Glasgow, will be open in about four months.

Electric Lighting at Singapore.—A report has been drawn up as regards the electric lighting of Singapore Town, which estimates that the cost of a suitable installation would amount to £70,000.

Belfast and the Electric Light. — At the monthly meeting of the Belfast City Council on Thursday last week, Alderman Connor announced that the Gas Committee had resolved to recommend the outlay of £300,000 to supply the electric light for the centre of the city.

Electric Lighting at Heckmondwike.—At the Heckmondwike ratepayer's meeting held last week to consider the electric lighting question, there was such a small attendance (owing to bad weather) that the meeting was adjourned until September 19th, in order that the matter might be very fully discussed.

Electric Lighting in Surrey.—A strong feeling exists among the inhabitants of Chertsey in favour of the introduction of the electric light in that town. The lighting inspectors at a meeting last week decided to invite tenders for illuminating the district by means of electricity. A conference is to take place with the Addlestone Lighting Committee with respect to a joint scheme for both districts. The sanitary authority having charge of Weybridge has decided to offer no objection to a further extension of three months asked for by the promoters of electric lighting for that town, in order that they might be able to raise capital and satisfy the requirements of the Board of Trade.

Electric Lighting of Bray.—We understand that the electric lighting of Bray, public and private, is now almost completed. For some time past Messrs. J. E. H. Gordon and Co., the contractors, have been running all the circuits, but owing to the water power being somewhat weak in summer, they decided not going under contract terms until the auxiliary steam plant, which was part of the project from the first, was complete. In the course of the next ten days the steam plant will be ready, and thus everything will be completed for the lighting.

The Electric Light at Hastings.—The Hastings Town Council, at a meeting last week, dealt with a report from the Public Lighting Committee, who recommended the acceptance of an offer by the electric light company to light the front line, from the Fish Market to the end of West Marina, for a period of three years, by means of 52 arc lamps 80 yards apart. The lamps would be lighted from sunset to midnight, after that hour each alternate lamp would be extinguished and the others be kept alight till sunrise, the company undertaking to maintain a steady light, free from extinctions, at £25 per lamp per annum. It was stated that about six months would be occupied in laying down the necessary plant. The committee's recommendation was adopted by nine votes to five, shareholders in the gas and electric light companies abstaining from voting.

Personal.—"Every South African," says *South Africa*, "will read with sincere pleasure the announcement that her Majesty has been pleased to create the Hon. James Sivewright, the Commissioner of Crown Lands and Public Works of the Colony, a K.C.M.G. This gracious recognition by the Cape Queen of Mr. Sivewright's great services will awaken a responsive loyalty throughout the colony, and, indeed, throughout South Africa as a whole. Few men better deserve those public honours that her Majesty distributes with a discrimination and judgment that adds so much to their value, than Sir James Sivewright, to whom we tender our most cordial congratulations." To many of our readers in the telegraphic world the name of Sivewright, in conjunction with that of Preece, as original joint author of Preece and Sivewright's "Telegraphy," will be well known. Although Sir James has long since ceased to be connected with telegraphic work, there are many who have worked with or under him in the English Postal Telegraph Service, now nearly 20 years ago, who will notice with pleasure the honours which he has attained.

"City Men at Home."—In the present issue the *City Leader*, under this usual heading, gives a short biography of Mr. R. E. B. Crompton.

Blackpool Electric Tramways.— We learn that on Tuesday last the Blackpool Town Council decided to purchase the electric tramways at Blackpool for the sum of £15,750. The Corporation take them over on Saturday (to-morrow).

Eccles and Electric Lighting.—At last Monday's meeting of the Eccles Local Board the Town Clerk was instructed to take the necessary steps to obtain a provisional order for the manufacture and supply of electric lighting.

Bowness and Electric Lighting.— The proposal of Messrs. R. H. Fell & Son, Limited, to lay electric lighting cables in Bowness, is receiving the consideration of the Local Board.

Electric Lighting at Southampton.—A Local Government Board enquiry was held at Southampton last week to consider the matter of applications made by the Town Council to borrow certain monies. Amongst the different items for which money was required was £600 for electric lighting and other works at the Otterbourne department.

Accrington Lighting.—The Accrington Town Council took a very unwise step on Monday last, when they resolved to purchase the gas and water works for £713,220, being 33 years' purchase, subject to the expert's report being satisfactory, and also if the ratepayers approved. Several councillors urged that the price was too much, in view of the progress of electric lighting.

Electric Lighting of Llanelly.—In connection with the proposed electric lighting of certain streets in Llanelly, the following was considered at last Monday's meeting of the Local Board:—"To receive a report of the committee of the whole Board upon the subject of the offer of the British Electric Installation Company, Limited, to take over the provisional order and cost of the same, the Board to have power to purchase the undertaking at any time within 42 years."

Vertical Gas Engines.—With reference to our remarks on vertical gas engines in our article of last week, on "Developments of Distribution," Messrs. Collins, of Bristol, point out that a small gas engine with inverted upright cylinders is being made by Messrs. Weyman & Co., of Guildford. Perhaps we were not quite clear in our remarks; we meant to say that the well-known types of gas engine had been hitherto made on the horizontal pattern. Of our knowledge there are makers who are turning out small gas engines on the vertical principle.

St. George's Vestry and the Electric Light. — St. George's Vestry, Southwark, has virtually resolved to adopt the electric light for its chief crossings. On Tuesday evening last, at a meeting of the Vestry, Mr. Hennessy moved "That this vestry consider the advisability of the electric light being placed on the top of the Obelisk (Blackfriars Road), high enough to prevent a horizontal shadow, and at the junction of the London and St. George's Roads, also in Marshalsea Road, Boro', opposite St. George's Church, and at the junction of the Old and New Kent Roads." There was a general feeling that the motion was a step in the right direction, but a decision on the motion was adjourned till the next vestry, when some idea of the cost can be forthcoming.

Dr. Kahle and the Clark Cell.—Dr. Kahle points out several printer's errors which have occurred in his paper published on August 26th. In the third paragraph, tenth line, the sense should be the free acid by boiling with zinc becomes allied to it, is thereby turned into zinc sulphate and loses its influence. In the table "t" should be read in the brackets instead of the + sign. The first paragraph, ninth line, should be $\frac{5}{10000}$ths, instead of $\frac{5}{100000}$ths; in the twenty-second line we should have said that the ampère deposits 4·025 milligrammes. Dr. Kahle states that he would be pleased to explain any obscurity to our readers, if addressed at Charlottenburg.

Failure of the Electric Light at Bilston.—The electric light with which the new Bilston Market House, opened a month ago, by Sir Alfred Hickman, M.P., was to have been illuminated has proved a failure. On no market evening since the building was opened have the lamps been at all satisfactory. Last Monday the apparatus broke down entirely, and not a single lamp could be illumined. The officials of the Brush Electrical Engineering Company, by whom the plant was laid down, have been inspecting the apparatus, and it is expected that its condition will be remedied in a short time.

Aberdeen and Electric Lighting. — The Aberdeen Town Council on Monday last resolved to proceed with the electric lighting of the eastern district of that city, at an estimated expense of £24,000.

BUSINESS NOTICES, &c.

Edison & Swan.—The Edison & Swan United Electric Light Company have just opened, as their headquarters for sales in London, one of the finest and best situated showrooms in the metropolis. The premises are at 110, Cannon Street, the entrance being at the corner of Laurence Pountney Lane. On the street front excellent show windows, 12 feet in height, have been made by cutting away the stonework of the building to within about 2 feet of the pavement. These admit plenty of light, and enable the whole interior to be seen from the street, while affording room for a good display of articles nearer the glass. The showroom, which is very lofty, has been tastefully decorated and elaborately wired, so that light can be switched on to most of the principal specimens on exhibition, current being available for about 250 lamps. Some ingenuity has been displayed in the effective arrangement of plain and fancy lamps in the handsome showcases lining the walls, the variety of lamps made being simply beyond enumeration. It has not been so well known in the past as it will be in the future that, in addition to the manufacture of lamps, the company is largely engaged in the making of every kind of electric light fittings, switches and switchboards, instruments, and in fact of everything required in installation work. In future, samples of all these may be seen at the new showrooms, which will be under the management of Mr. Charles Manners Downie.

Hanley and Electric Lighting.—The General Purposes Committee of the Hanley Town Council recommend that the electric lighting sub-committee be empowered to arrange all details regarding the electric lighting of the town. It was reported at Tuesday's meeting that nine tenders had been received, and all the schemes were high tension, and with one exception were all alternating current schemes. The committee recommended the acceptance of the tender of the Brush Electrical Engineering Company, amounting to £15,760, and that application be made to the Local Government Board for sanction to borrow such amount, together with the sum of £5,240 required for buildings, trenches, and other works, repayable in 60 years; that an application be made to the Board of Trade for their approval of the system to be adopted; and that the corporate seal be affixed to a provisional contract between the Corporation and the Brush Electrical Engineering Company, for the carrying out of the work. The recommendations were adopted.

Electric Lighting at Hayle.—On Saturday evening last the electric light was inaugurated for the first time in Copperhouse on the premises occupied by Messrs. J. and F. Pool, metal perforators and ironmongers, Hayle. The contract was secured by Mr. F. M. Newton, electrical engineer, of Taunton, and the work has been most successfully carried out by his representative, Mr. Edgar Pool. The motive power used for driving the Taunton dynamo is supplied by the engine which drives the perforating machinery. The dynamo is capable of supplying 36 16-candle-power lamps. Each lamp has also a separate switch. During the evening an electric search light was displayed from the rear of the premises by Mr. Pool.

Derby Electric Lighting.—The Derby Town Council Improvement Committee have purchased certain land from Mr. S. Bagshaw for £600, for the purpose of enlarging and improving the new electric lighting station when occasion requires. The electric lighting committee have accepted the tender of Messrs. Geo. Fletcher and Co., of Derby, for boilers and accessories at the electric light station. The building and dynamo contracts are in preparation. The committee recommended the appointment of a resident electrical engineer, to act as clerk of the works during their construction, and to manage them when completed.

The Chili Telephone Company.—This company has recently obtained an important concession from the Chilian Government, whereby the latter binds itself to use the company's telephones in all the public offices to the exclusion of all other systems. The contract is to remain in force for ten years, and the rates paid are to be the same as those actually ruling, but subject to certain modifications dependent upon the rate of exchange. In return the company obliges itself to expend the sum of £30,000 in improving its installations and plant.

The Sunbeam Lamp Company.—The Sunbeam Lamp Company have lately brought out a price list and circular, in which they inform the public that although they have, for the time being, ceased the manufacture of the "Sunbeam" lamp, they continue to supply their patent "Sunbeam" holder, which is said to be very simple and neat for large incandescent lamps. The Edison and Swan United Electric Light Company are now making lamps to suit these holders.

Electric Light in Mines.—An electric lighting installation was started at Stanley Colliery, Stanley, last week. The plant which was put down by Messrs. F. C. Royce & Co., of Manchester, consisted of a No. 2 dynamo, 2 arc lamps and 12 incandescent lamps of 16 and 32 candle-power. The engine was controlled by a Pickering governor, and everything worked satisfactorily. As well as lighting the colliery the same plant also illuminated West Hallam Station and the adjacent roads.

Woodhouse & Rawson, United.—A notice has been circulated by Messrs. Woodhouse & Rawson's Pretoria house, notifying their intention of reducing their prices all round for house-wiring and fittings, &c., in connection with electric lighting, to extend their market for home-made articles. Accompanying the circular is a list of some of the electrical work done in Pretoria by the company. Mr. P. J. Van der Byl has been authorised to canvass for orders in that town.

New Lists.—We have received a copy of Revised List No. 31, of the India-Rubber, Gutta-Percha and Telegraph Works Company. Detailed prices, illustrations and other information regarding galvanic batteries, are the chief features in the pamphlet. The construction of the Leclanché cells and batteries of porous pot form and agglomerate form is explained. The list will be very serviceable to the company's customers, and users of batteries in general.

Electric Lighting for Dolgelly.—The Dolgelly Local Board, at their meeting on Friday afternoon, decided to light the town with electricity. The contract was entrusted to Messrs. Hall, of Liverpool, whose tender was about £5 cheaper than the gas company offered to light the town for. Messrs. Hall promised to be ready to light the town within a fortnight. The amount agreed to pay for lighting the town during the winter is £80.

Tenders Wanted—Glasgow.—The Glasgow Corporation Tramways Committee invite persons desirous of submitting estimates to equip certain of their tramway routes for working on the overhead wire system, to communicate with their general manager, Mr. John Young, City Chambers, Glasgow.

Conservative Club.—The contract for the wiring of the Conservative Club, St. James' Street, which work, as mentioned last week, is being carried out under the superintendence of Mr. A. A. C. Swinton, has been placed with Messrs. Hancock & Rixon.

Personal.—Mr. Reginald John Jones, M.I.E.E., and A.M.I.C.E., has by a deed poll duly enrolled, renounced the surname of Jones, and will in future always assume and use the surname of Wallis-Jones.

Bankruptcy.—Mr. James Collins, electrical engineer, of 80, Church Road, Hove, was on August 30th adjudicated bankrupt in the Sussex Bankruptcy Court.

CITY NOTES.

City of London Electric Lighting Company, Limited.

THE second annual general meeting of this company was held on Thursday, September 1st, at Winchester House, Old Broad Street. Sir David L. Salomons, Bart., chairman of the company, presided over a comparatively small attendance of shareholders.

Mr. J. CECIL BULL, the secretary, having read the notice convening the meeting, the report of the directors and accounts (printed in these columns on August 26th) were taken as read.

The CHAIRMAN said: On the last occasion upon which I had the honour of appearing before you, it was with a considerable amount of difficulty I waylaid one shareholder in the passage and got him for an audience. I am pleased to see to-day that we are so many in this room: it shows that if before you had complete confidence in your board, at any rate now your interest is waking up, while I trust your confidence is not lessened. I propose now, before moving the adoption of the report, to place before you all that has taken place since the last meeting. On that occasion I gave you the history of the formation of the company up to the date of that meeting. I will now continue from the point at which I was then compelled to break off to the present day. In regard to the shares, applications for which had been made to the extent of £300,000, leaving £100,000 worth to be applied for, I am glad to say that now the whole of that amount has been applied for, and the money will be employed on your works in a very short space of time. Therefore, the whole of the ordinary share capital is taken up, and in a very short time, probably in another month or six weeks, that money will be spent, and you will see how it will be spent directly. It is therefore the intention of your board to issue the preference stock. The intention at present is—and no doubt it will be carried out—to issue half the preference stock, £200,000, at 6 per cent., and to give the shareholders the first chance of obtaining it. Perhaps you may say it will be difficult looking at the amounts, to discover what I am going to say, but you will find, from a few words to be mentioned directly, that this 6 per

cent. is very well secured, and may be regarded as a first-class property when in your hands. I myself, and I think the board, also, will in a great measure agree with me, believe that, I do not say in a month or six months, but let us say, not to be too hopeful, within twelve months, we shall be in a position to pay a dividend to the ordinary shareholders. Matters are now beginning to mend; the first difficulties that have to be encountered have been met—and very satisfactorily met—and matters are beginning to turn. The stations are working now, not at a loss, but at a small profit, and as the machinery goes into work and the full load is put on, the money will come in, and nearly every penny will go to profit, for the standing charges do not increase in proportion; it is merely that the coal bill goes up. The increase is comparatively small after the staff has been paid, and the office expenses and various other matters which must be met, have been disposed of. We have at the present time certain matters, sources of expense, at the works which must exist, and which bring in no return. That is a necessity with all companies and undertakings of this kind. All the money that we now expend you may say will be fruitful. There are one or two points in the report that I should like to call your attention to. One is this: On page 3 there are these words: "From calculations based on the lamps already connected to the company's mains, it appears that the consumption of current per lamp installed in City offices, shops, &c., will be much greater than was anticipated." It was pointed out to me by a gentleman that that might be taken to mean that the consumers of electric energy in the City are paying more than in other districts, or, in some way, were at a disadvantage. This was said by a gentleman who intended to light up his office, and I thought it important to explain the matter to him, and I will repeat the explanation, lest anyone else should fall into the error indicated. It means this: in the West End, where there are drawing rooms and people giving parties occasionally, whilst for a great part of the time they are away, and shops that are lighted up for only a short period, we find that the lamps installed is four times the number in general use. Imagine for a moment that a lamp can earn, burnt throughout the year fairly, £2. If the average is only a quarter, every lamp installed would produce only 5s. But in the City matters are different. All the lamps installed—probably almost all—are in use when the weather is dark, and consequently the return to the company will be far in excess of that where only a portion of the lamps are in use on a particular day. It means that circumstances in the City are specially favourable to the future of the company. I should also mention another point which has frequently come under my notice, and I do not address this to gentlemen here particularly, but rather to our customers outside this room. It is the importance of not stinting money in putting up your fittings. You will find in the long run that it is much better to have the work done well at the start. Nothing has brought a bad name more quickly on electric lighting in many places than the fact that the wiring and fittings have been bad. I point this out, because with water, gas, and drainage, and other things, people are most particular, whilst with regard to electric lighting, as a general rule, the man who will give the lowest tender is given the job, and the consequence is it is not satisfactory in the end, and very often it ends in an accident. I have no doubt most of you have been round the City and seen the beautiful illumination there is now at night. You will see it better by-and-bye, when the evenings become short, and you do not return to your homes before daylight goes. One thing will strike you, that all that is put up and in sight is thoroughly well done. There is no bad work anywhere, and if I were to invite you to go through the City and examine what has been done underground, you would see that what is out of sight is just as well done as that which is in sight during the day. If you go to the works you will find the same thing, although you will find things in some confusion there, with the builders about, and machinery being erected; but you would see that what is being done is being thoroughly well done, not like that of some concerns, where the projectors make a show for the purpose of rigging the market, and then get out of it. This is a model concern, a model to London and to all other great cities of the world. It is not at all a hurried affair or badly put up, nor is it calculated to bring a bad name on the City or any of us connected with it. I can assure you the members of your board have not spared themselves any trouble, nor have they refrained from putting themseves to any inconvenience of a private nature, but have, in every way, given their time and attention to every detail, no matter how small, connected with this affair. No money whatever has been spent without being first brought before the board, and all details considered, and before voting that money, we go into the experiences of other companies of a similar nature to see what they have done, where they have failed, and where they have succeeded, and try, as far as possible, to profit by both their failures and their successes, rather than to strike out on new lines for our own glorification. There is only one matter which I greatly regret to bring before you. It is, that one of our directors has for some time past been away from his duties, not through any neglect, but through the misfortune of illness. Mr. Charteris, who had taken such intelligent interest in what we have been doing for a long period, was suddenly taken ill and has been away for a long time. I saw him yesterday; he was returned from abroad and is very much better; we may hope soon to see him at the board once more. In the accounts you will find a considerable amount of money for calls in arrear, £1,500 odd. At this day only £62 is left unpaid, and, no doubt, that will come in in the course of a few days. The accounts as now issued, are simply issued because we are obliged to do it. I cannot say myself, to put it honestly, that they give you very much information; they do not give me very much information, and perhaps others see it in the same way. The fact is, during the progress of work it is extremely difficult to separate different items. But at the end of this year, when we are obliged under certain headings to return a statement of accounts, as required by the Board of Trade, we shall make up our accounts in the proper form and they will be sent round to our shareholders, so that they may see how we really stand. I do not mean that there is anything bad or cooked in these accounts, but the facts of expenditure and receipts have been put down as best they could be; but by-and-bye, they will be separated and you will see what they mean. After this time they will always be issued, in conformity with the Board of Trade Rules, as soon after December 31st in every year as possible. I dare say you will be pleased to hear a little about what we have been doing, although I quite admit it is very dry, as it consists in great measure of figures, but there are numbers outside this room who are watching our progress: and it will interest others, no doubt, quite as much as it will the shareholders to see what really can be done in a short space of time, and fairly done, without being accomplished in a hurried manner. A number of curves have been drawn out, which perhaps to a great many not accustomed to them will convey no meaning whatever. But the intention is to have these curves kept up, whether they be for or against us, and we shall have them photographed and sent round with the report annually, in order to instruct our shareholders in this manner as to what we are doing and as to the progress maintained, and to give those outside the company who follow our work as scientific men, or as being interested in like industries, an idea of what the truth really is; we are most anxious to give the truth in every respect. The top curves give the working expenses and the progress of the lamps. One line—the pink one—indicates what you may call the current, the gross receipts, and the brown line the lamps; that is, combined arc lighting and the private lighting. You will notice that when we began early in the year we were under every possible disadvantage; that is always so. There the expenditure exceeded—not very much, but it did exceed—the return. Now as the lamps increased, so you will see the red line keeps creeping up, and at length it goes above the expenditure line. Now, just as we were on the turn, the summer months were over, and we had to keep our stations ready for larger demands. Now it is on the turn, the darker evenings are beginning to set in, and already the receipts are considerably in excess of the expenditure. The bottom diagram gives you the connection of lamps. You will notice we began with very few: the number kept going on, and it is now at a goodly figure. The top curve of the diagram shows the growth of public lighting; that line is rapidly going up in the same way. For a long time, whilst the material was being delivered the lighting remained practically stationary. As the material came in and was put down in the proper place the lighting increased, and you will see how that curve runs up. The lighting of the city, for which we have taken the curves—and which constitutes our business—shows a very exceptional experience. In the West End, and, in fact, most other places, most of the curves I have seen hitherto indicate a considerable amount of lighting after a certain hour in the afternoon, depending on the time of the year, and dropping down again soon after eight o'clock, so that in the winter the lighting is chiefly between the hours of four and eight. In the City, it appears, it will be quite different. The amount of current required for the whole day is far more constant day by day, which is naturally a very good thing for the shareholders, because we shall not be running machinery for nothing. There is one thing we shall require experience of—a London fog. We had a little experience with a dark cloud the other day, which frightened us for about 20 minutes, but that experience was such that the trouble will not occur again. We want a favourable winter from our point of view, dark days and fogs, to see what the City population really requires. The board have it always in view to supply the current as cheaply as possible, but in the beginning it will be unwise to put down the price until we know what the return is going to be. As soon as the shareholders get a return for their capital, and the funds—sinking fund, renewal, and such like funds—are provided for, then any extra profit, after a fair return, you, I am sure, will join with the board in agreeing, should be devoted to the reduction of the price of the current. That will come very soon, no doubt, but it will be dependent purely upon the support the outside public give us. I cannot speak too highly of the work done by our officers and *employés*, who have been giving their attention, I may say, almost day and night continuously to hasten the work as much as possible, without anything being hurried over. It only requires a little patience on the part of the public until we get the works slightly more forward; you cannot work with the same freedom when you have bricklayers and builders and others amongst you as you can when they are away. But after a few months' work we think our results will compare with those of any other company in London. There is one thing the board have done with a view to the future. There will undoubtedly be a demand for electric energy for lifts and running machinery, for cranes, advertising purposes, and a hundred other matters, probably now little dreamt of. In order to meet such a demand, we have laid underground a vast number more ways than will be immediately required. My own opinion is, that before we are many years older, the whole of these ways will be occupied, and we shall have to modify our system, or have the City up again to lay down more ways. It may be hoped that that necessity may not arise for a good many years; but if there be the demand for electric energy, it will have to be provided for, and it is not at all unlikely that the demand will have grown so much after another five years, that we shall not really know where we are. But at any rate, for a long period to come, the inconvenience which would be caused by pulling up the streets a second time is avoided by our having laid a certain number of these spare ways. The cranes, pumps and other machinery at the stations are proposed at this moment to be worked by electric motive power, which, besides being convenient and cheap, will prove to the public that if we can do it economically there, it will be economical for them to do the same. One matter which also claims our attention very much is that we hope that many markets, railway stations, and other public places will obtain current from us; but up to this time, the Board of Trade rules will not allow any public

company to supply current under these conditions, as they only allow a certain pressure between the terminals where the mains enter public buildings, and arc lamps to be supplied at a certain price, and by no means can arc lighting be supplied under those rules. I attended a deputation to the Board of Trade the other day, and Sir Henry Calcraft and Sir Courtenay Boyle received us in the kindest possible manner, and as a result, they agreed that the rules should be altered if certain precautions were taken; but these precautions are not yet finally settled as regards details, and no doubt every case will be separately considered as to the precautions necessary. It simply shows this, that a large public department has no wish whatever to impede electric lighting, but on the other hand, has every wish to give every possible facility to make electric light the light of the future, and possibly I might even say the light of the present. If any gentleman wishes to have these curves explained further, we shall be most happy to explain them afterwards. I now come to some figures which, I think, will be of very great interest. I may tell you that, in giving you these figures, it is our wish to have no secrets. By giving you the fullest information, be it good or be it bad, we enable you to judge for yourselves how matters really are going. A great many companies in the past—I don't think they do it so much now—kept matters to themselves, and did great injury to the cause of electric lighting in consequence. By the spring of next year, 1893, it is expected that our stations will be able to supply 78,000 8-C.P. incandescent lamps, in addition to the 700 arc lamps which we could supply at this moment. That is the total: that allows nothing for reserve, so that we could not light that full number. It gives you what we could do, but a certain proportion, say, 20 per cent., will be kept in reserve. When you consider what a winter we have passed through and how much we have been pressed, the starting of the company having been so recent, I think you will agree that what we have put down probably beats the record, and certainly it is beyond all precedent so far as I am able to ascertain. Now, for instance, the gross earnings exceed £20,000 a year, and this will increase continually as we are supplying the current. In fact, every increase now of so much a year will be in considerable measure clear profit. Although at this moment we are distributing this energy under very unfavourable circumstances, our machines being only half loaded, and the works only partially completed, still the loss does not exceed 26½ per cent., and I think any gentleman present who has had any scientific or practical experience will know that 26½ per cent. under such circumstances is exceptionally favourable. When the machines get fully loaded that will become a comparatively small figure. The next figures are in respect of the machinery which is being erected, and that will be up very shortly. Those machines, or similar machines, have been running, and give 10 per cent. higher capacity for continual working than was contracted for. Even the machines in now will give this, and I think that is extremely creditable to the contractors, because, as a rule, when a contractor gives you an article specified to do a certain thing, it will do it, and no more, and very often will only do that under peculiar conditions not always obtainable in practice. To give 10 per cent. in excess on all occasions, is very creditable to them, and very sati-factory to the company. Those machines are intended to give current for 6,000 8-C.P. lamps. As regards fogs, which will be one of our great enemies in one sense, and our greatest friends from the dividend point of view, we propose to take a certain course as an experiment: whether it will succeed is another matter. We propose to take observations from certain points, so that we may know when fogs are coming. The Docks Committee have kindly promised to inform us when fogs are coming up or down the river. No doubt, other departments will give us telephonic communication as soon as they know a fog is coming from different points round London. This sounds very well, and may be very effective; but at the same time I must tell you, that fogs may come from quite a different direction from what we anticipate, and the whole of these precautions fail. But we shall do our best to find out, and if they come slowly, say they give us 10 minutes' notice, that will be sufficient. If they come down suddenly from overhead, it may involve us in difficulties, unless we keep a captive balloon continually on the look out. As regards street work, as much as 30 miles of tubing have been put down in a week. The average for the year has been about 10 miles per week. The contracts with the City for street lighting in the main thoroughfares required 47,072 yards of trenches to be dug, and by June 30th, 43,134 yards had been completed; at this moment 45,410 yards have been laid, leaving only 1,662 yards to complete, and that will be down in the course of the next two or three weeks. Now, in addition to this work, in the smaller streets, described as lesser streets, and there it is not compulsory, on June 30th there were trenches laid to the extent of 46,378 yards, or about 26⅓rd miles. At this moment about 49,412 yards are laid. Up to the present time, taking everything, there have been about 303 miles of ways laid. The length of cable drawn in to-day is 63¼ miles at high tension and 22 miles at low tension. On June 30th there were in seven streets 184 arc lamps, which made themselves very conspicuous long before June 30th to those who went into the streets at night; but at this moment there are 334 lamps, and by the middle of September, that is to say, by the middle of this month all that are compulsory under the City contract will be running, excepting a few delayed for special reasons; that is, where building operations are in progress and hoardings come out over the pavement, so that we cannot put up our lamps, and where refuges are being reconstructed. Our last day for completion of contract being November 5th, I think no one will complain that we have not taken every possible means of being in good time. It is a rare thing for contractors to have their work completed two months before time. On June 30th—the accounts are made up to that date, and that is why I state the position then—11,860 8-C.P. glow lamps were running on 6,735 yards of main. This gives per yard of main two lamps density. If this were to hold good throughout the district where the streets are all ready for the mains, it would give 100,000 8-C.P. lamps. In Lombard Street, the lamp density per yard is as high as six, and in Cornhill it is almost the same. Two stations, since August 1st, have been supplying current day and night continuously. The board felt that it was a very important point, if possible, to give the light continuously, because it is most unsatisfactory where for periods, even if only an hour a day, the machinery is stopped. Nothing is more likely to prevent people from coming in to your mains than that. I hope, in putting so many dry facts and figures before you, I have not tried your patience too far, but we felt it our duty to let you know what we were doing, and at future meetings we hope, whatever is done, to make you fully acquainted with it in the same way. Now, I have only to move: "That the report and accounts of the directors of the company be and are hereby adopted."

Mr. J. C. PURCELL seconded the resolution, which was carried without dissent.

The CHAIRMAN: There is one more resolution. Messrs. W. H. Pannell & Co. are our auditors, and it becomes necessary, now, that they be re-elected for the ensuing year, and it is necessary that you should agree as to the remuneration which they should receive. We have suggested 100 guineas as a fair value, if some gentleman will move that.

Mr. PURCELL moved, and Mr. KELMAN seconded, the re-election of Messrs. W. H. Pannell & Co. as auditors, at a remuneration of 100 guineas per annum, and the resolution was agreed to.

The CHAIRMAN: That concludes the business, except so far as any gentleman may wish to ask any questions.

A SHAREHOLDER: I see you are getting rather short of money. I want to know what you are going to do with regard to that in the future. I was not here at the beginning of the meeting, and possibly something was said about that.

The CHAIRMAN: I mentioned earlier that we propose to issue £200,000 of our preference stock, giving the shareholders the first chance of taking it, at 6 per cent. That will be done in the course of another month or so.

Mr. MORRIS: I should hope that you will manage to get some premiums to wipe off this escape of £69,000 as far as possible.

The CHAIRMAN: I think there is some misunderstanding as to that. That is not £69,000 paid to the Pioneer Company for nothing; by far the greater proportion of it represents work done and handed over to us.

Mr. MORRIS: Yes! However, I think if you are going to issue 6 per cent. stock, you ought to get a premium, for it to wipe off that. I should think the shareholders and the public would be very glad to give some small premium.

The CHAIRMAN: You see, what the board have in mind was to give the shareholders a little advantage at the start, and only issue a portion of the preference. The next lot of preference no doubt will be issued at a very considerable premium.

Mr. MORRIS: It occurred to me that it would be an advantage to get rid of that dead weight.

The CHAIRMAN: No, no. We have got value for that. You must not go out of the room with that impression.

Mr. MORRIS: It is not complete value; you cannot say that. They must have got something out of it.

Mr. COTTAM: Before leaving, I must ask you to pass a vote of confidence in our chairman and the board, because at the present time, starting a company of this magnitude, must require most careful and delicate attention. I happen to have been a shareholder for some ten years in the old Brush Company. I cannot say that, financially, I am satisfied; still, I have faith in the electric light, and I am sure we are all indebted to our board, who look after our affairs, and with regard to dividends we must look to the confidence of the public. I ask you to pass a unanimous vote of thanks for their services during the past year.

Mr. SMART seconded the resolution, which was carried unanimously.

The CHAIRMAN, in replying, said: I am sure I may say on the part of my colleagues and myself, we fully appreciate the vote of thanks you have passed. The only thing I judge by in private life is results, and I have given you now the results in regard to the expenditure of your money. I trust next year, or when we next meet if it be earlier, we shall be able to show results in what we have earned for you.

The meeting then terminated.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending September 4th, 1892, amounted to £737; corresponding month, 1891, £672, increase £65; total receipts to date for half-year, £7,690; corresponding period, 1891, £7,069; increase £621.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts for the month of August amounted to £3,100, as against £3,111 in the corresponding month of last year.

The Direct Spanish Telegraph Company, Limited. The receipts for the month of August amounted to £1,884, against £1,631 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The traffic receipts for the month of August amounted to £49,069, as against £53,398 in the corresponding period of last year.

The Great Northern Telegraph Company. The traffic receipts in August, 1892, amounted to £23,600. 1st January—31st August, 1892, £175,600; corresponding months, 1891, £189,400; corresponding months, 1890, £181,000.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 2nd, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, amounted to £3,105.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation September 1st.	Closing Quotation, September 8th.	Business done during week ending September 8th, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 —103	100 — 103	100½	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	47½— 48½	48 — 49	48¼	...
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	88 — 89	89 — 90	90	89½
2,849,510*l*	Do. do. Deferred	Stock	10¼— 10⅝	10½— 10⅝	10 9/16	10½
130,000	Brazilian Submarine Telegraph, Limited	10	10⅝— 11¼	11¼— 11⅝	11⅝	11⅜
53,200*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	105½	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3½— 3½	3½ — 3⅝	...	...
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2¼— 2½	2⅜— 2⅝	2¼	2 3/16
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½— 3½	2½— 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152 ...	10	10 — 10½	10 — 10½	10¼	10¼
$7,716,000	Commercial Cable, Capital Stock	$100	160 —165	160 —165	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	⅛ — ⅜	⅛ — ⅜	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½ — 5⅝	5½ — 6	...	...
16,000	Cuba Telegraph, Limited	10	10½— 11¼xd	11 — 12xd	...	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18xd	17 — 18xd	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 3¾	3¼— 3⅜	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11⅜ — 11⅝	11½— 11⅝	11⅝	11 5/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅞— 15⅛	14⅞— 15⅛	15⅛	14⅞
70,000	Do. 6 p. c. Preference	10	15½— 16	15½ — 16	...	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109	106 —109	108⅜	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	110 —113	110 —113	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15¼	15 1/16
78,300*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	} 100	103 —106	103 —106	104	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	104⅜	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	108 —111	108 —111	...	...
135,000*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	} 100	103 —106	103 —106	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	104½	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5 — 5½	4½— 5	5 3/16	4⅞
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	¾— 1	⅝— ⅞	⅞	¾
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅛— 2⅜	2⅛— 2⅜	2 9/16	2 7/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅛— 1⅜	1⅛— 1⅜	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10½— 10½	10½— 10½	10½	10 5/16
180,042	Do. do. 6 p. c. Preference	10	15⅝— 15⅝	15⅝— 15⅝	15 9/16	...
150,000	Great Northern Tel. Company of Copenhagen	10	18½— 19	18½— 19	...	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108xd	105 —108xd	106⅜	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	5½ — 6½	5½ — 6½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½ — 10½	9½ — 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ — 22½	21½ — 22½	22¼	21½
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	104 —106	104 —106	...	...
17,000	Indo-European Telegraph, Limited	25	42 — 44	42 — 44	43½	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½ — 3½	2½ — 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16— 3 9/16	3 7/16— 3 9/16	...	...
10,000	Do. do. fully paid	5	5 1/16— 5 3/16	5 1/16— 5 3/16	5⅛	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108xd	105 —108xd	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6⅝— 7¼	6⅝— 7¼	...	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 5	4⅜— 5	4 15/16	...
15,000	Do. 6 p. c. Cum., 1st Preference	10	13½— 14¼	13½— 14¼	14¼	13 5/16
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13 — 13½	13¼— 13⅜	13 9/16	13 7/16
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	109 —111	109 —111	110¼	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	4 — 5	4 — 5	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 — 5/16	3/16 — 5/16	...	..
9,000	Reuter's Limited	8	7 — 8	7 — 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7½ — 8	7⅞— 8¼	8	7⅞
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8¼	8 — 8¼	8⅜	8¼
3,381	Submarine Cables Trust	Cert.	116 —121	116 —121	118½	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3½ — 4	3½ — 4	3⅝	3½
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	42 — 44	43	..
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	..
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½ — 7½	6½— 7½	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	99 —102xd	100 —103xd	101¼	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 —106	...	...
67,007	Western and Brazilian Telegraph, Limited	15	8⅝— 9¼	9 — 9¼	9⅜	8⅝
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6½— 6⅝	6½	...
30,364	Do. do. do. 5 p. c. Deferred	7½	2⅜— 3½	2⅜— 3½	...	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1½ — 1⅝	1½— 1⅝	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9¼ — 9⅜	9¼ — 9⅜	9 11/16	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	101 —105	101 —105	103	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	123 —128	123 —128	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	97 —102xd	97 —102xd	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅜— 6¼	5⅜— 6¼	6 1/16	6

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid) 7½—7⅞.—Electric and General Investment, shares of £5 (£1 paid), 2⅜—3⅛.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6⅜—7½.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2½—3⅛.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅜—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5½—6.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Metropolitan Electric Supply Company, Founders' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid, 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 103—⅛.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—¼—£5 Preference (fully paid), 2½—3.—Ward's Electric Car (£10 paid), 1⅛—1⅜.

BANK RATE OF DISCOUNT.—2 per cent. (April 28th, 1892

REVIEWS.

Street Railways: their Construction, Operation, and Maintenance (Trams). A Practical Handbook for Street Railway Men, by C. B. FAIRCHILD, Editor of the *Street Railway Journal*. Published by the Street Railway Publishing Company, World Building, New York, 1892.

This is a book which is intended to give to practical tramway men the actual facts of practical working. It makes, as stated in the preface, little pretence to literary merit, but is rather a compilation of workshop notes. Seeing how rapidly the electric tram is superseding all other modes of serving passenger traffic between towns and residential districts, and what complicated knowledge is required to be a successful tramway manager, there seems to be a large field of usefulness along the lines laid down by Mr. Fairchild.

In Europe the book can only interest a few, but in America it will no doubt be, as intended by the author, a handbook to the street railway man. The contents are divided into 14 chapters, the first three, treating of electric, cable, and horse traction being the most important. Chapter VII. is devoted to elevated roads, and gives a very full description of the details of construction. Chapter VIII. deals with car building in a most thorough manner, indeed it appears to have been written by the foreman constructor of some tram-car manufacturer. In Chapter IX. the laying and building of the track is discussed, and the various methods in vogue are described and criticised. The remainder of the book is chiefly filled with questions of commercial and economic importance, and will be of great interest to the general and traffic managers of tramlines both in Europe and America. A point of especial attraction is a section on the book-keeping and the classification of tramway accounts.

The volume is of the same size as the *Street Railway Journal*, and contains 427 pages. The illustrations are both numerous and good, and explain many of the practical points without any need of reference to the text.

Electric traction has been so unfortunate in Great Britain that we fear the book is not likely to meet with a large sale on this side; but it will well repay men who are interested in this class of work to carefully study the contents. The index is compendious and renders a reference to any particular branch of the subject quite easy.

Hydro-Electric Methods in Medicine. By W. S. HEDLEY, M.D. London: H. K. Lewis, 136, Gower Street, W.C.

This book is mainly a reprint of articles which have recently been published in the *Lancet*, and *British Medical Journal*. It is, consequently, somewhat fragmentary, and, as the author puts it, is "a collection of electro-medical papers connected up," not even "in series" but rather "in groups." Each group stands by itself and deals with a definite problem.

The author shows a thorough acquaintance with the subjects touched upon, his reasoning is close and logical, while his style has a refreshing crispness about it. These facts in themselves render the book a welcome addition to the literature of electro-therapeutics, but its most important characteristic is the stress laid throughout upon the need for proper attention to the physics of the subject. The preface tells us the book is partly designed as "a protest against the idea that electro-therapeutics is merely medicine with a 'streak' of electricity through it," and concludes with: "It appears to me that if ever we are to succeed in formulating laws for rational electrisation, it can only be by, in the first instance, trying to get behind the very complex physical conditions that in electro-therapeutics we invariably have to encounter." This point has hitherto received far too little attention from medical writers, and we gladly welcome Dr. Hedley's endeavour to inaugurate a more healthy tone by giving it due prominence.

The first group is "Hydro-electric" and deals with several forms of electric bath. The complex problem of the physics of the ordinary electric bath has been tackled with considerable ingenuity, and what appears to be a near approximation of the truth arrived at, though unfortunately the solution is not yet. An interesting feature in this group is the experiments made with an electric douche showing the distance to which the current may be carried in a jet of water when properly arranged. Group II., termed "Facts and Fancies," seems rather out of place in the book and more suited to a popular magazine, still the "facts" appear to be sound, and the "fancies" not improbable. Group III. deals with medical currents and points out their various effects upon the body. The unsuitability of the word Faradic as applied to coil currents is shown, and the effect of currents of high frequency and potential touched upon. In Group IV. we are informed upon "Other Sources of Supply," and in dealing with current from the main careful directions for the protection of the patient are given. This group also includes a decidedly caustic article on "The Continuous Coil Helix," wherein a pet device of a prominent American electro-therapeutist (or electro-therapist as our author writes it) is rather mercilessly dissected. In the next group the author discourses upon the "electro-therapist," and insists upon the need for such an one to possess a thorough and intelligent knowledge of his subject. In Group VI. we find "The Current that Kills" under consideration, and a suggestion made that in the American electrocutions it is most probable that the actual killing is done at the medulla oblongata. Group VII. adds somewhat to our knowledge of body resistance, and we note with interest that by a special test under bath conditions the author found the R to be 540 ohms. The last group is entitled "Aids to Electrical Treatment," and deals with movement, massage and medical gymnastics.

It is curious that a book so excellent in tone and thorough in matter should be lacking an index, and be ornamented with a frontispiece wherein electrical apparatus, a bath tub and some domestic furniture are shown in a very disconnected "group." These, however, are small blots easily remedied in the future, and we hope that so sound and readable an author as Dr. Hedley will not allow this to be the last work (as well as the first, we believe) to issue from his pen.

WATER POWER.

BY E. TREMLETT CARTER.

(*Continued from page* 285).

IV.

15. *Sluices and Valves.*—Contrivances for altering or regulating the flow of water through the engine are, when placed in open conduits, called *sluices* or *gates*, and when placed in pipes, *valves*. In an open conduit mill there are usually two sluices, one at the far end of the head race serving the purpose of a stop-valve, and one close to the engine serving the purpose of a throttle or regulating valve. In many

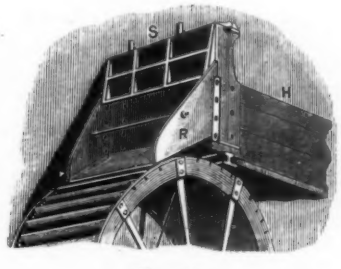


FIG. 13.

mills the regulation is effected by hand power, but for electrical purposes this is not sufficiently prompt or reliable, and automatic regulators or governors must be attached to the second sluice. Although it will be inadvisable to discuss the methods by which this regulation is carried out before having considered the engines themselves, yet it will be in place here to consider the design of the sluice, more especially in connection with the loss of power which it causes.

A sluice usually consists of a flat slide of sheet iron or well-seasoned and creosoted oak, capable of being moved vertically upwards or downwards between guides, in the manner in which

modern English window-sashes move. The motion is communicated by means of a couple of racks and pinions, as shown at S in fig. 13, or more clearly in fig. 14. The width of the gate should not exceed 4 feet, and when a wider stream than this is to be admitted, it will be necessary to have two or more separate gates, each worked by an independent pair of racks.* The depth of the opening depends on the class of engine to be supplied, as also does, to a certain extent, the form which the sluice takes. Two of the most common sluices are shown in figs. 13 and 14; the former

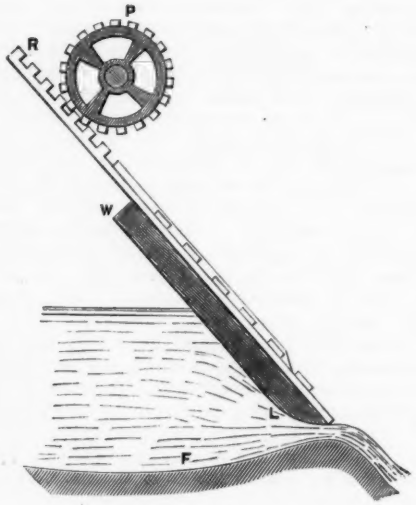


FIG. 14.

being vertical and the latter inclined at an angle with the vertical. The advantage of the latter kind lies in the gradual approach and reduction of section which the stream receives, but it has the disadvantage that the slide presses heavily on the guides and causes considerable frictional resistance to motion. There are certain forms of engine in which the inclined sluice is indispensable, and, on the whole it is preferable to the vertical pattern. It will be noticed that the lower edge or lip of the sluice is curved towards the approaching stream, and that the timber is here very thick. This is in order to produce a smooth and efficient flow of water through the opening, wasteful eddy currents and contraction being largely eliminated. In some cases the floor, F, is also curved upwards, in a parabolic curve, towards the lip of the sluice, producing the same economical result.

Owing to the pressure of the water in the penstock against the face of the sluice, and the high statical coefficient of friction at the guides, a very considerable force is required to start the sluice when a change in the flow is to be produced. The pressure on the sluice is,

$$p = 62{\cdot}4 \cdot \frac{w\,D^2}{2} \text{ lbs.},$$

where D is the depth of the immersed portion, and w is the width of the sluice, in feet. The coefficient of friction for wetted oak planks, sliding in wooden or rough iron frames, is 0·72 before motion commences and 0·25 after it has commenced. Taking the former and higher figure, we have for the force required to start the sluice,

$$f = 22{\cdot}5\ w\ D^2 \text{ lbs.}$$

If the regulation is to be effected by hand, the design of the winch for working it must be such that this maximum force can be produced by a force of about 30 or 40 lbs. at the winch handle. If it is to be effected by means of an automatic governor, it is evident that some supplementary gear will be necessary; that is to say, the force is such that it would be useless to expect the governor itself to exert it, and the necessary effort must be obtained from some other source, usually the engine, by means of supplementary gear. In the case of large sluices under very deep water, a separate hydraulic engine is often used for working the sluice alone.

Closed conduits are usually provided with a stop valve and a regulator or throttle valve in each branch, and a single stop valve in the main pipe. To prevent bursting on account of shock when the water is checked, each pipe should also have a safety or relief valve, communicating with a channel or pipe leading directly to the tail race. Loss of head in the regulator or stop valves cannot be avoided when these are not full open, since there must be a reduction of the section of the stream; but they should always be designed so that when there is full gate the water has a clear way *straight* through them. In passing through valves the water should not have to turn corners or alter its section; in fact, the valve when full open, should form an uninterrupted continuation of the pipe. This being the case, hydraulic valves are usually flat slides moving into or out of a recess in the side of the pipe, and covering the whole or only part of the channel according as they are drawn entirely or partially from this recess. At full gate the slide is stowed away in the recess and the passage through the valve is as easy as through the pipe itself. A valve of this form, similar to the ones used at the recently opened Tivoli station, is shown in fig. 15, and in section in fig. 16. By turning the wheel, W, the screw, S, is

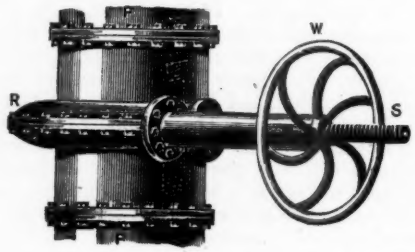


FIG. 15.

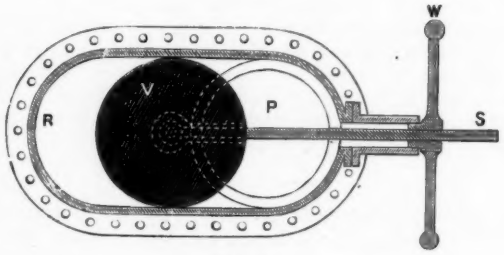


FIG. 16.

drawn from or pushed into the pipe, P, and the circular slide, V, which is fixed to the other end of this screw, is caused more or less to intercept the passage from the upper to the lower pipe, P. The recess, R, is large enough to take the whole of the slide when the valve is full open. The only objection to this pattern of valve is that the screw crosses the channel, and thus to a certain extent intercepts the flow and gives rise to eddies. It would have been better if the screw had been worked from the other side of the recess, R. From the conditions of efficient working which have been laid down it will be seen that it is impracticable to have balanced valves; and that therefore there will be a very considerable thrust on the slide against its seat, which will render it difficult to move the valve quickly by hand. Under great heads this pressure may be so great that it would be impracticable to work the valve by hand; when it will be necessary to fix a small hydraulic ram or water-pressure engine to the slide, as shown in fig. 17. By raising the little handle, H, water is caused to exert a pressure on one side of a piston in the cylinder, C; by depressing the handle the water is caused to act on the other side, thus raising or lowering the slide.

16. *Examples.*—A few numerical examples relating to mill details will now be discussed, before passing on to consider the engines.

(*a.*) *A wooden sluice has a width of 3 feet and a maximum immersion of 4½ feet. It slides in wooden guides vertically up and down. Find the force required to open it.*

Total pressure on sluice $= \frac{1}{2} \times 3 \times (4{\cdot}5)^2 \times 62{\cdot}4$ = 1,895 lbs. Taking the coefficient of friction as 0·72, the force of friction is

$$1{,}895 \times 0{\cdot}72 = 1{,}364{\cdot}4 \text{ lbs.}$$

And this, added to the weight of the gate, is the force required to open the sluice.

(*b.*) *What is the loss of head at a slide valve when set so as to reduce the section of the passage to one quarter of its full amount, the velocity of the water in the pipe being 4 feet per second?*

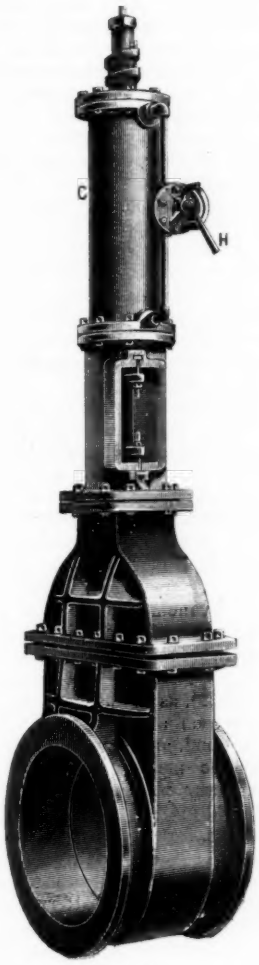


FIG. 17.

Here we may take $c = 0{\cdot}62$, then the loss of head is

$$h = (6{\cdot}4 - 1)^2 \cdot \frac{16}{2 \times 32} = 7{\cdot}3 \text{ feet.}$$

N.B.—With twice the section of pipe the loss of head would have been only 1·81 feet.

(*c.*) *A head race is 25 feet long and of rectangular section, 5 feet wide and 2½ feet deep; what is the loss of head when the velocity of the stream is 5 feet per second over the bed; and what is the loss of H.P. at the race, if the mean velocity is 6 feet per second at this time?*

The H.M.D. of this conduit is equal to one half its depth, or 1¼ feet. Whence the loss of head is

$$h = \frac{25}{2 \times 32} \times \frac{25}{1{\cdot}25} \times 0{\cdot}0074 = 0{\cdot}0617 \text{ ft.} = \tfrac{3}{4} \text{ in. (approx.)}$$

And since the discharge is 75 cubic feet per second, the loss of power is

$$\text{H.P.} = \frac{0{\cdot}0617 \times 75 \times 62{\cdot}4}{550} = 0{\cdot}56 \text{ (approx).}$$

(*d.*) *An overfall weir is to be built in the channel of a stream 25 feet wide, so as to discharge water over its whole width. The maximum discharge per second will be 325 cubic feet and the head, or swell, produced by this discharge is to be 18 feet. What must be the height of the crest of the weir above the bed of the stream?*

The height of the top water above the crest is,

$$h = \sqrt[3]{\frac{(325)^2}{7\,(25)^2}} = 3 \text{ feet}$$

This leaves 15 feet for the height of the crest above the tail water. Now, assuming there is a clear flow away from the weir, the depth of the tail water will be approximately,

$$d = \frac{2\,Q}{b\,\sqrt{2\,g\,H}} = 8 \text{ inches}$$

which gives 15 feet 8 inches as the height of the crest above the bed.

(*e.*) *All the water of a brook discharging 30 cubic feet per minute is to be used for running a water wheel during the hours from 9 a.m. to 6 p.m., with a variation in head of only one foot between starting and stopping. What must be the area of the mill pond?*

The mill is not running for 15½ consecutive hours, and during this time the pond is filling at the rate of 30 cubic feet per minute. The total amount stored is,

$$Q = 30 \times 60 \times 15 = 27{,}000 \text{ cubic feet.}$$

And since the rise of level is to be one foot, the area of the pond will be 27,000 square feet.

17. *Classification of engines*:—The manner in which the water develops useful power in the engine forms the most satisfactory basis of classification. Formerly engines were divided into a class in which the motion was in a vertical plane, called water wheels, and a class in which the motion was in a horizontal plane, called turbines; but, it has for some time been the practice of electrical and other engineers to place turbines on a horizontal axis, and there are other reasons why this basis of classification is neither convenient nor scientific. The following system of classification will be adopted in these papers.

I. *Open Conduit Engines, or Water Wheels*:—(*a*). Weight and impulse engines, comprising (1) overshot and (2) brest wheels. (*b*). Impulse engines, comprising undershot wheels.

II. *Closed Conduit Engines, or Turbines*:—(*a*). Impulse engines, comprising (1) parallel flow turbines, (2) radial flow turbines, (3) jet or tangent flow turbines. (*b*). Reaction engines.

III.—*Water Pressure Engines.*—Action by weight occurs when the water turns the engine by virtue of a fall of water actually inside the engine; by impulse when the engine is driven by the impact of water which enters it with a certain velocity and loses some of the velocity in driving the engine, and by pressure when the engine is driven by the virtual head caused by the weight of a superincumbent column of water outside the engine. Many engines combine two of these sources of useful action.

18. *Overshot Wheels.*—In these the water is supplied over the top of the wheel, the level of water in the penstock being considerably higher than the top of the wheel, and the jet or stream issuing from the sluice falling some distance before entering the engine. Fig. 13 shows the arrangement of the wheel with respect to the sluice, S, and the head race, H, and it will be seen that the water passes from the sluice on to a shoot or wheel race, R. During its descent from the surface level of the penstock, the water acquires a certain velocity depending on the fall to the sluice and the subsequent fall to the wheel, and with this velocity it enters the wheel. Owing to friction at the gate and over the wheel race, the velocity acquired is less than the theoretical velocity due to the fall; it is usually calculated from the following equation:

$$v = 0{\cdot}96\ \sqrt{2\,g\,h_1},$$

where v is the absolute velocity of the water in feet per second, and h_1 is the difference in level of the top water and the point of entry into the engine. The distance, h_1, is called the *guide fall*. Entering with some kinetic energy, the water is enabled to do work by virtue of its impact tangentially to the wheel; that is to say, part of the energy of the guide-fall may be utilised on account of the forward push which the wheel will receive from the entering stream. Having exerted a useful effort in entering, the water now lies quiescent in the wheel in suitably formed buckets, and exerts a continuous effort on account of its weight. Falling with the turning wheel through a distance, h_2, called the *wheel-fall*, the water now reaches a point near the bottom of the wheel, where it is discharged. It has already been said

that the water is supplied *over* the top of the wheel, and a little consideration will show that where this is the case the wheel must turn against the tail water. In order to avoid the friction which would arise from the wheel turning *in* the tail water, it will, therefore, be necessary to provide a certain drop from the bottom of the wheel to the surface of the tail water, thus making it necessary for the water to fall a distance, h_3, called the tail-fall, from the point of leaving the wheel to the level of the tail race. The sum of three falls, h_1, h_2 and h_3 is, of course, the available head at the engine, and is equal to the available head at the mill site less the loss due to friction in the channels and sluices. It will be necessary, in designing an overshot wheel, to decide on the proportion between these three distances. In the first place we shall consider the guide fall and the amount of work which the water can do in virtue of its impact against the wheel on entry.

(To be continued.)

THE CURRENT THAT CURES.

By H. NEWMAN LAWRENCE, M.I.E.E.

(Continued from page 283.)

III.—How Current Cures.

This, the last part of our subject, requires approaching with extreme care. It is often said that no one knows how electricity acts upon the body, that there is extreme uncertainty in its results, and that when it does good it is faith and not the current that achieves the cure. That there is a fair amount of reason in these statements, any one who has had experience in practical electro-therapeutics will readily admit, but that they are more true of electricity than of any other remedial agent employed in treatment of disease, there is good reason to doubt.

Let us take the faith question first. Faith is a most important factor in deciding the efficacy of any remedy resorted to. It is as true of the society physician's prescription as it is of the gipsy's charm. Have we not all heard of, and many of us experienced as children, the efficacy of bread pills. We were told, and having faith in our elders, believed, that the pills would do us good ; and so they did. As we get older we often find that one doctor can always do us good, while others equally distinguished and using the same remedies never can. Simply because we have faith in the one and have not in the others. Only a few weeks ago I was told by the matron of a hospital that she had assisted in putting a restless patient into a sound sleep by a hypodermic injection of *pure water*. The patient was informed that this injection would send her to sleep, and faith produced the desired result. If these things be true, and we must all admit them in some form or other, surely it would be the height of absurdity to argue that pills and hypodermic injections are valueless because on some occasions they have wrought good results by means of the faith of those who received them rather than by the drugs they were supposed to contain ; or that the most popular doctors should be boycotted because they cure some of their patients by faith rather than by works. As long as human nature is what it is the mind will have its fits and cranks of credulity and faith in individuals, in events, and in remedies will remain essential to human comfort and happiness. Electricity comes in for its share of the advantages arising from this faith aid, but there is nothing to show that its share is greater than that falling to other remedial agents. Of course it will be understood that I refer to the results of *bona fide* electrical treatment and not to the marvellous faith and flannel cures so freely advertised by the electric (?) belt and appliances fraternity.

Next, as to the uncertainty of results in electrical treatment. The human body is so complicated and *individualised* a structure that it is hard to see how we can be quite certain of the results of any form of treatment upon it. Besides, when other things are favourable the faith factor may entirely upset all calculations, for while in some cases it helps or even entirely performs the cure, in others it may retard or even prevent it. Other forms of treatment have their uncertainties as well as the electrical, and not always, perhaps, with so good a reason. The main cause of uncertain results is to be found not in the current itself but in the way it is administered. "Haphazard" and "happy-go-lucky" are about the only words I can think of to characterise the methods genenally employed. No measurement, no knowledge of the functions of currents, no idea of the resistance of the body, no attention paid to surface area or to current density, and often even the most rudimentary knowledge of matters electrical entirely absent. If the current be not measured the dose may be too weak or too strong. Of course it *may* be just right, but the chances are two to one that it is not. Too great chemical action may easily be not only useless but distinctly harmful. Nerve and muscle stimulation are valuable to a certain point, but is it not possible to over stimulate, and so turn good into evil? Who can properly select the form of current in any case when ignorant of the functions of such currents? How can any current be properly applied when nothing is known of the resistance of the body which it is desired to influence, or how to direct the current so that the parts treated shall be really affected by its flow? And, lastly, how in the name of common sense can good results be expected, or serious injury avoided, when an agent so potent for good and evil is applied to the body by persons entirely innocent of the most elementary knowledge of electricity?

It may be thought that I am taking an exaggerated view of the state of affairs, but, in all seriousness, I am not. Some few there are in the medical profession who stand forth as bright examples in this matter of measurement and careful administration, but the general run of them are well content to avoid all attempt at accuracy. Let me give one or two instances from my own experience. In one well known London Hospital I saw, a few weeks back, several patients under electrical treatment, where to four batteries there was only one galvanometer, and *that was not in use.* Cells were switched on or off according to fancy, the same sized electrodes seemed to be used in all cases, and the patient's sensation appeared to be the only guide to the strength of current, and, as far as I could see, no readings of the time given to each application were taken. A gentleman, with M.D. Lond. and several other high qualifications, once applied to me for *a coil battery* to use for *electrolysis.* A country practitioner told me he did not think there was much in the treatment of stricture of the urethra by electrolysis, for he had tried it without success. On questioning him, I found to my horror that he had applied (of course, without any measuring instrument in circuit) 30 cells of a Leclanché battery (five or six being generally enough for this purpose) to his unfortunate patient's urethra, and was then surprised at the startling result. I thought he was lucky to have escaped a criminal prosecution for assault. Another practitioner, this time in London, came to question me about a battery which he was using upon a case of internal tumour in a woman. I found that he knew absolutely nothing about electricity, or the management of a battery, and thought it altogether too much trouble to read the galvanometer. Yet this man went down into the country, no doubt at a good fee, to treat a *most delicate*, and perhaps critical case by an agent of which he *knew nothing, obtained from a machine he could not manage.*

A considerable number of medical men who use electricity in treatment simply order a nurse or assistant to make the application, taking little or no trouble to ascertain how far such nurse or assistant is competent, and giving only the vaguest instructions. Then what qualification have the nurses or assistants for the work entrusted to them? For the most part little or none. They have, perhaps, had lessons from some instructor (?) who professes to teach "the battery" (whatever that may mean), and the whole art and science of massage to boot, *in three weeks*, and then, having armed themselves with a battery, come forth as full blown and *certificated medical electricians.* These, and such as these, the busy physician entrusts with the electrical treatment of such of his patients on whom he wishes to try electricity.

The process is somewhat analogous to giving to an unqualified chemist's assistant a prescription which, while naming a powerful drug, does not define the dose. No physician in his senses would think of doing this, and yet it is the daily practice of many in matters electrical. Who can wonder

that the results are uncertain? May we not rather express surprise that good should ever be effected by such means.

Again, we are told as another reason against its use that no one knows how electricity acts upon the body. Do we *know* how anything acts upon the body? We know how drugs act upon substances similar to those contained in the body, and we know that certain results generally follow their introduction into the body; but that is about as far as medical science can go, at present at any rate. The famous remark of the judge presiding at the Maybrick case, that physicians were gentlemen who spent their lives in putting drugs of which they knew little, into the human body of which they knew less, was but a truism somewhat sarcastically expressed. In electrical matters the state of knowledge is at least no worse. Electrical currents produce certain effects upon inanimate substances. Physiologists show us that the body contains similar substances, and that some of its most vital processes are dependent upon changes practically identical with those which electricity brings about in the inanimate substances. This, and the fact that certain results generally follow certain applications to the body, go far to show that the actions of electricity upon the human organism are not so entirely incomprehensible as some would have us believe. Indeed, as shown by what follows, it may be fairly claimed that we know quite as much of the action of electricity on the human organism as we know of the action of the countless drugs that daily find a place in the prescription of the physician.

(*To be concluded.*)

ELECTRIC MOTORS VERSUS STEAM LOCOMOTIVES.

THIS is a question by no means thoroughly grasped by a large number of engineers, and no little nonsense has been talked by irresponsible men, both from the steam and electrical points of view. Some seem to suppose the steam locomotives to be incapable of higher speeds than those usually obtained; but judging from experimental runs made both in England and America, there is not the slightest reason for such supposition. It is not the capability of the locomotive that limits train speeds, it is the question of cost, difficulties connected with combined slow and express services, crossings on grades, curves, &c. Indeed, it is obvious to those versed in railway matters that a higher rate of speed will necessitate a separate line for the express trains; and this cannot be made commercially profitable until such traffic is sufficient to pay for the increase of cost.

Granted a field for a train service at a rate of 100 miles per hour, it is more than probable that electricity will supply the demand better than steam at some future date, but not now. For it is clear from the method of applying electric motors to railway work, and from the results obtained on the few small railroads worked electrically, that very radical changes must be made before it is possible. The electric motor of to-day lends itself to propelling light trains, but is at present altogether incapable of dealing with the heavy loads moved with ease and certainty by the steam locomotive. Light trains, with frequent service, are suitable for passenger traffic in crowded cities, and also between towns and residential districts; but they require so many hands to work them that there is little chance of such a service competing with heavier trains for ordinary long distance traffic.

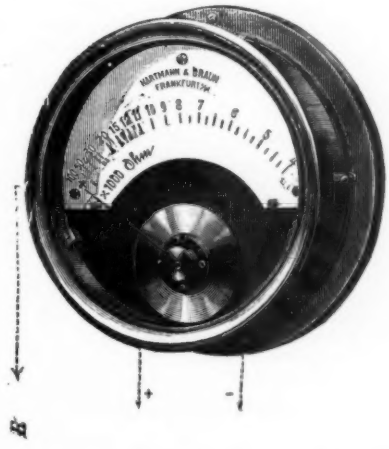
Messrs. Crosby and Bell have carefully worked out the general problem, and they find from a number of calculations that, with a net efficiency of 60 per cent. for the electric motor, gearing and regulating device, electricity becomes more economical than steam at about 140 miles per hour; and that for 80 per cent. efficiency the two are about equal at 60 miles per hour. But 80 per cent. efficiency has not yet been attained, we believe, on any of the electric locomotives now running. If these figures be correct, as they are tabulated in *The Electric Railway*, there is no hope for electric engines on goods lines.

Mr. Arthur T. Woods, writing in *Electrical Progress and Development*, summarises the present status of electric *versus* steam locomotives as follows:—

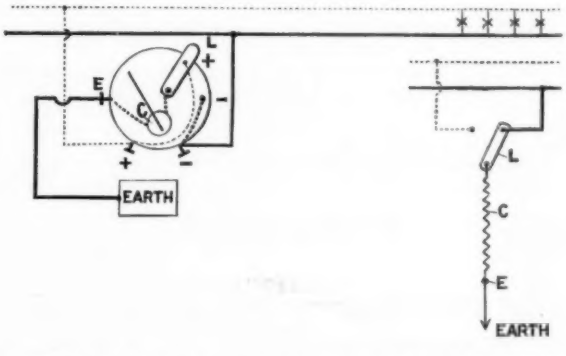
1. There is no prospect of electricity replacing steam for long distance freight traffic.
2. There is a possibility of electricity becoming an economical substitute for steam locomotives for high speed service wherever the traffic is sufficiently heavy and constant to warrant the construction of lines of track independent of those used for moderate speeds.
3. There are very few localities in the United States in which the conditions are such as to make such a substitution commercially possible, with the efficiencies at present obtained with electrical machinery.
4. If the electrical equipment could be purchased at reasonable prices, there are a few short lines of steam railroads on which the passenger traffic is such as to make electricity a possible form of motive power at present speeds.
5. It is probable that electric locomotives will be used in tunnels and for switching in cities where freedom from smoke is important.
6. No electric locomotive capable of doing the work of a medium-weight steam locomotive has as yet been constructed.

HARTMANN AND BRAUN'S NEW EARTH LEAKAGE INDICATOR.

MESSRS. HARTMANN & BRAUN'S earth leakage indicator has an outward appearance like an ordinary 9-inch voltmeter. The difference of potential remaining constant and as the instrument is measuring the current, the readings can be taken direct in ohms.



The readings of an earth leakage indicator designed for a 2,000 volt circuit range from 2,000,000 to 200,000 ohms; this range can be diminished to any extent (for instance from 1,000,000 ohms to 100,000 ohms, &c.). It is connected up as per sketch and as follows:—



Terminal E is to be connected to earth; the terminals marked + — are to be joined to the main whose insulation is to be tested. By means of the lever, L, either the one or the other lead can be connected to earth through the coil C. If the opposite pole has an earth leakage a current flowing

through the coil, C, will deflect the arbor, which latter will indicate the same direct in ohms. All parts of the instrument are extremely well insulated and the coil is soaked in paraffin wax. The instrument may be used either with direct or alternating currents.

NEW PATENTS—1892.

15,113. "Manufacture of caustic, soda and potash, and hydrochloric acid by electrolytic treatment of chloride of sodium and chloride of potassium, and apparatus for this purpose." J. P. ROUBERTIE, V. LAPEYRE, and U. GRENIER. Dated August 22nd.

15,120. "Improvements in or applicable to electrical accumulators or secondary, or storage batteries." H. W. HEADLAND. Dated August 22nd.

15,167. "Electrically illuminated signs or devices, partly applicable to other purposes." B. J. B. MILLS. (Communicated by A. D. Page and E. J. McAllister, United States). Dated August 23rd. (*Complete.*)

15,170. "Improvements in or connected with electro-magnetic alarm apparatus." B. HOFFMANN. Dated August 23rd.

15,179. "Improvements in arm rests for telephone operators." J. R. BAILEY, L. C. LINCOLN, and THE WOONSOCKET EDGE TOOL COMPANY. Dated August 23rd. (*Complete.*)

15,188. "Improvements in electric arc lamps." E. F. H. H. LAUCKERT. Dated August 23rd.

15,194. "A new or improved telephone transmitter." E. L. MAYER and A. C. JAMESON. Dated August 23rd.

15,197. "Improvements in electrolytic apparatus." H. M. E. ANDREOLI. Dated August 23rd.

15,225. "A new electric contact lamp." C. A. J. H. SCHROEDER and H. E. R SCHROEDER. Dated August 24th. (*Complete.*)

15,238. Improvements relating to telephonic switching apparatus." A. R. BENNETT. Dated August 24th. (*Complete.*)

15,240. "Improvements in jointing or junction boxes for electric cables or wires." HAYWARD TYLER & Co., and C. P. HAMMOND. Dated August 24th.

15,296. "Improvements in and appertaining to electrical accumulators." H. C. BULL and J. RAMAGE. Dated August 25th.

15,298. "Improvements in holders for incandescent electric lamps." F. BRYAN. Dated August 25th.

15,299. "Electric apparatus for operating the unfastening and fastening of doors." J. GORIUP. Dated August 25th.

15,315. "Improvements in electrical batteries and their application for curative and remedial purposes." R. W. H. NEWINGTON and E. PRIDDLE. Dated August 25th.

15,318. "Improvements in electrical transformers." H. H. LEIGH. (Communicated by G. M. Apollonj, Italy). Dated August 25th. (*Complete.*)

15,319. "Improvements in and relating to electric batteries." D. FEDERMAN. Dated August 25th.

15,329. "Improvements in gas, electric light, and lamp fittings." E. HORTON. Dated August 26th.

15,346. "Improvements in obtaining ammonia, hydrochloric acid, and chlorine, from ammonium chloride, also in obtaining chlorine from hydrochloric acid, and in the apparatus used." F. BALE. Dated August 26th.

15,356. "An improved electro-chemical process for treating iron pyrites, thereby recovering everything valuable contained therein and avoiding all noxious fumes." H. C. BULL. Dated August 26th.

15,372. "Improvements in the method and means of obtaining electricity." W. BOGGETT. Dated August 26th.

15,376. "An improved system of automatic telegraphy." F. O. CLAPCOTT. Dated August 26th.

15,377. "Improvements in switches for electric lighting." R. L. HATTERSLEY. Dated August 26th.

15,405. "Improvements in and connected with telephone switches." H. OPPENHEIMER. Dated August 27th.

12,426. "Manufacture of an elastic compound for electrical insulation and other purposes." J. W. SAVAGE. Dated August 27th.

15,437. "An improved method of making electrical contacts between parts of electrical apparatus." W. E. GRAY and W. A. PRICE. Dated August 27th.

15,441. "Improvements in arc electric lamps." A. J. HOWES. Dated August 27th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

14,386. "Improvements in or appertaining to electric motors." G. C. DYMOND. (A communication from abroad by L. Gutmann, of Pittsburgh, America.) Dated August 25th. The principle of the invention may be described as follows:—If a drum or ring armature in which the connections of the various coils have been made to form a closed circuit (without the usual commutator), and in addition, if we connect here and there electrically some of the coils in groups of twos, threes or more, then by subjecting this modified armature to the influence of a field magnet excited by alternating electric currents, a very powerful repulsion and rotation are produced by the combined repulsive actions of the armature and the field. The cause of this repulsion lies in the new method of winding contrary to usual practice. In ordinary armatures the winding forms a single closed circuit, and if exposed to the excited two-pole field magnets, it will produce two currents equal in strength and opposite in direction. If no outside connections are made at the points where the two currents meet, no current will be found, as there is a balance or equilibrium in the armature current, consequently no rotation would be experienced. 19 claims.

16,767. "Improvements in apparatus for electric cooking and heating." F. W. SCHINDLER-JENNY. Dated October 2nd. Consists in passing an electric current through a suitable conductor, which is placed in numerous windings upon the surface of a refractory non-conducting plate. Upon the conductor, so arranged, is placed a thin covering of refractory, insulating material, which for its protection may again be provided with a metallic cover. 7 claims.

16,870. "Improvements in a combined brush, brush-holder, and lubricator for dynamo-electric machines." T. SUTCLIFFE and E. H. ATKINSON. Dated October 5th. Consists of a reservoir to contain any lubricant, and constructed in one with the brush-holder, so that by placing and attaching the aforesaid parts a clasp will be formed, whereby the device shall be attached to and supported by the bar provided for that purpose. 5 claims.

17,454. "Improvements in electric conductors for the distribution of electric currents and in conduits therefor." R. THRELFALL. Dated October 13th. Consists partly in a new or improved conductor for the distribution of electric currents particularly adapted for use underground, and which is so constructed that the section of the said conductor may be increased as required with cheapness and facility, and so that the number of insulating supports which are ordinarily required for a conductor placed underground may be lessened. The invention further comprises the construction of a cover for an underground conduit for such or any conductor so as to render the conduit completely water-tight, and to admit of its being readily opened as required for making connections or other purposes. 3 claims.

17,614. "Improvements in couplings for electric wires." A. SHIELS. Dated October 15th. Has for its object to make what are known as "Shiels & Elliot" couplings for electric wires, so that they can be drawn asunder when necessary or desired. Under this invention, the inventor makes the bearing surfaces rounded, angled, or of other suitable conformation, so that when the parts are coupled together they will come asunder before the coupling itself, or the connecting pipe, breaks. The side or fish plate is made of sufficiently thin material, or has a spring on or in it, so that it will give way and allow the bearing surfaces to unclasp when the abnormal strain takes place. 1 claim.

17,731. "Improvements in electric motors." O. LINDERS. Dated October 16th. The improved motor comprises an oblong frame or ring cast in one piece, which constitutes the magnetic circuit, the cores of the magnet being united with the said frame or ring or formed in one piece therewith. At the ends the said frame or ring has cylindrical openings for receiving the bearings for the armature shaft situated in the plane of the ring, and passing diametrically through the same. One of the said openings is made of such a size as to allow the armature to be introduced through the same for fixing the said armature in position. Plugs or caps are screwed into the bearings for the purpose of supporting the shaft against displacement and for adjusting the said shaft in the longitudinal direction. 3 claims.

17,732. "Improvements relating to electric motors." O. LINDERS. Dated October 16th. Relates to an electric motor provided with means by which the said motor may be suspended in such a manner that it may be swung around itself in a vertical plane. 3 claims.

17,733. "Improvements in electric machines for drilling, boring, grinding, and the like." O. LINDERS. Dated October 16th. Relates to an electric drilling or boring machine which has a spindle adapted to be displaced relatively to the electric motor and passing through the hollow armature shaft, the motion of the latter being transmitted to the said spindle in such a manner that the speed of this spindle will differ from that of the armature. 2 claims.

17,994. "Improvements in and relating to electric batteries." B. SCHEITHAUER. Dated October 20th. Consists in hermetically closing the outer vessels of the cells and continually introducing oxygen gas into them at such a rate that all the hydrogen which is liberated at, or deposited upon, the negative electrode will at once combine with the said oxygen to form water. 1 claim.

18,641. "Improved method of driving dynamo-electric machines.' B. F. KELLY. Dated October 29th. Claim:—The improvements in electrical apparatus in which wind mills are used as the motive power whether for direct use from the dynamos or for storage in secondary batteries, substantially as set forth and shown.

18,902. "Improvements in the manufacture of tubular conduits for electric conductors." G. F. REDFERN. (A communication by S. BERGMANN, of Berlin.) Dated November 2nd. Claims:—1. The manufacture of tubular conduits for underground electric wires, cables and the like, by saturating and coating a paper tube with a liquid insulating substance and surrounding it with a tightly fitting metal cover either before or after such treatment, substantially as described. 2. Tubular conduits for electric conductors made in the manner referred to in the preceding claiming clause.